

FM 55 - 9

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UNIT AIR MOVEMENT PLANNING

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UNIT AIR MOVEMENT PLANNING

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*This manual supersedes TM 55-450-15, 4 June 1971.

PREFACE

Air movement is an air operation executed in accordance with prepared plans designed to insure air transport of supplies, equipment, and personnel. A unit's mobility capability requires that the unit be able to package, document, onload/off-load, and tie-down equipment.

This manual provides an overview of the air transportability considerations of Army personnel and equipment, including aircraft loading procedures and related fundamentals and techniques. While the fundamental principles and techniques discussed pertain to Air Force aircraft, the same general principles apply to Army aircraft.

This manual, together with FM 55-12, AR 59-106, and TM 38-250, provides a unit commander the basic guidance needed for planning and executing a successful deployment by air.

Use of the words "he," "his," and "men" throughout this manual are intended to include the masculine and feminine genders unless otherwise noted.

The Transportation School is the proponent for FM 55-9. Recommended changes and comments are encouraged, and should be sent to the Commandant, US Army Transportation School, ATTN: ATSP-TD-TL, Ft. Eustis, VA 23604.

CHAPTER 1

INTRODUCTION TO AIR MOVEMENT

Air travel is the only transportation method that meets situations in the world requiring rapid response by the armed forces. Air movement of units requires planning by all levels of command. Units must be trained not only in mission accomplishment, but also in the skillful execution of a deployment by air. This chapter provides a brief overview of the air movement missions and responsibilities, as well as general instructions for the conduct of an air movement.

AIR MOVEMENT AUTHORITY

Unit movement by air from or within the Continental United States (CONUS) will be authorized by Headquarters, Department of the Army (DA). Unit air movement between overseas major Army commands or from an overseas major Army command to CONUS is authorized by the Joint Chiefs of Staff (JCS) or the Department of Defense (DOD) in coordination with DA through JCS. DA normally publishes instructions and movement authority to the Army components of unified commands to implement DOD and JCS directives.

MOVEMENT DIRECTIVE

The movement directive is the basic document, published by DA, which directs units to prepare to move and move from home stations in one of the following categories:

CATEGORY A. A move from home station with all equipment that is authorized to the unit.

CATEGORY B. A move from home station with minimum essential equipment (MEE) only.

CATEGORY C. A move from home station with less than minimum essential equipment. Specific guidance as to what to take will be given in the movement directive.

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AIR MOVEMENT
AUTHORITY

MOVEMENT DIRECTIVE

DEPLOYMENT
INSTRUCTIONS

TYPES OF MOVEMENTS

SAFETY

SUMMARY

DEPLOYMENT INSTRUCTIONS

Army major commands or Army components of unified commands will issue guidance to the moving unit in the form of deployment instructions. These instructions generally cover personnel deployability criteria, type of equipment to be taken, medical support to be provided, and special logistical and administrative instructions. The information follows standard procedures for preparation for oversea movement (POM) outlined in AR 220-10.

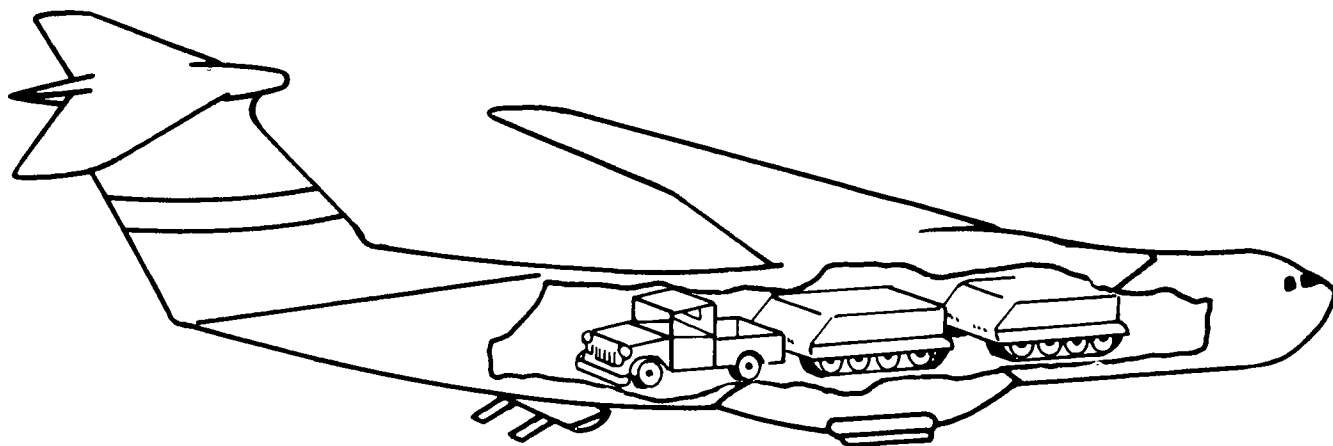
TYPES OF MOVEMENTS

Depending on the urgency of the situation and the need for moving a unit and its equipment by air from one location to another, the method of loading is determined by the type of movement directed in the deployment instructions. There are two types of movements:

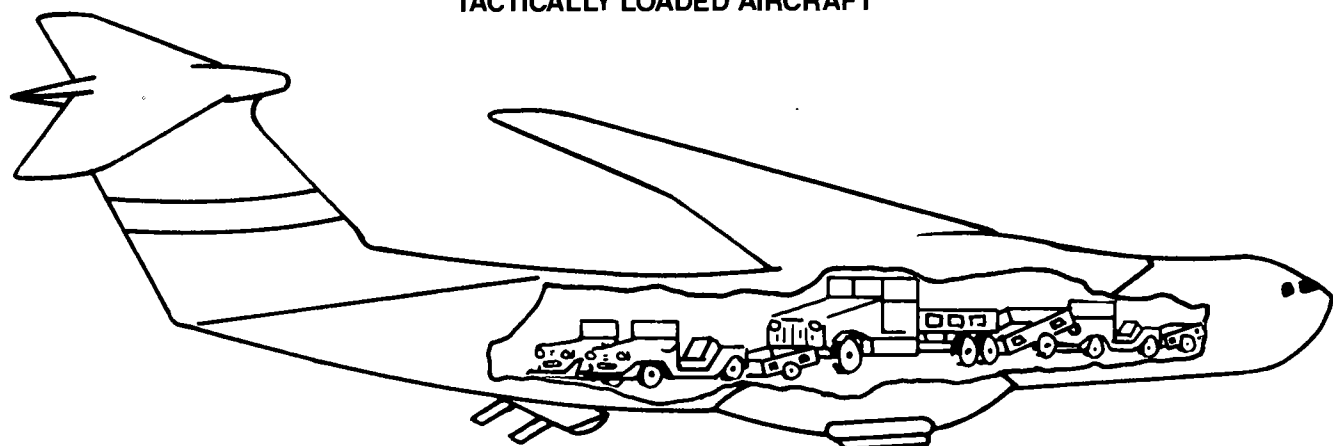
- Administrative movement
- Tactical movement

Administrative Movement. An administrative (strategic) movement is a nontactical movement in which troops and equipment are arranged to expedite their movement and conserve time and energy when no enemy interference or contact, except by air, is anticipated. This type of movement emphasizes economical use of the aircraft cabin space and personnel or equipment to be arranged so that maximum use is made of the allowable cabin load (ACL). ACL is the amount of cargo and passengers, as determined by weight, cubic displacement, and distance to be flown, which may be transported by specific type of aircraft. You may disregard unit integrity or off-loading sequence when planning an administrative movement.

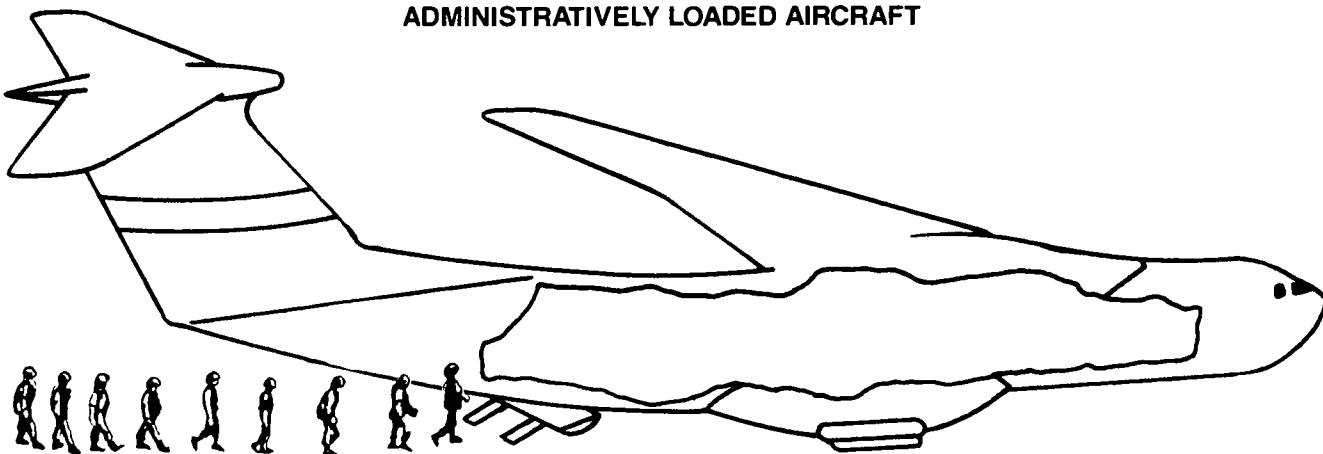
Tactical Movement. Tactical movement, a movement of troops and equipment that is organized, loaded, and transported in such a manner as to facilitate accomplishment of a tactical mission. The arrangement of personnel and stowage of equipment and supplies is designed to conform to the anticipated tactical operation of the unit. Proper utilization of the aircraft ACL is still the most important factor, but the commander's sequence of employment will have to be given greater attention than in the administrative move.



TACTICALLY LOADED AIRCRAFT



ADMINISTRATIVELY LOADED AIRCRAFT



TROOPS BOARDING AN AIRCRAFT

SAFETY

It would be impossible to anticipate all situations that could be covered with a specific safety rule or precaution. However, safety is a major consideration in any airlift movement. Injury to personnel or damage to equipment must be prevented at all cost; not only is such injury or damage objectionable in itself, it may also seriously jeopardize accomplishment of the mission. Safety is the result of effective training, common sense, and alertness. The observance of safety, therefore, is a continuous responsibility of all commanders and each individual.

Specific safety measures for vehicle operations during aircraft loading are covered in FM 55-12. The following additional safety rules must be observed.

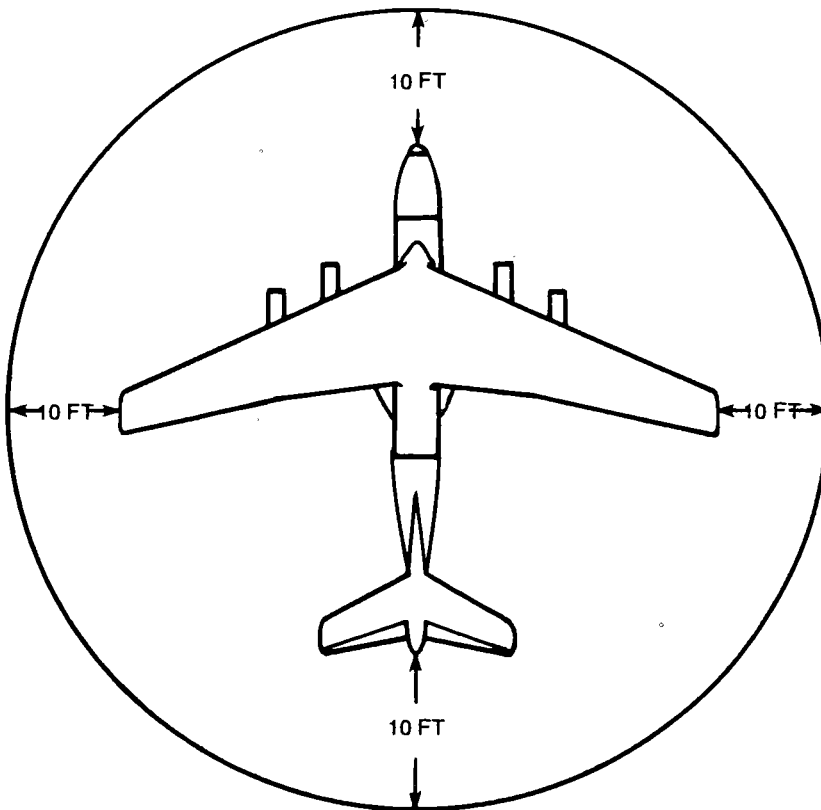
TROOP MOVEMENT ON AIRFIELD

Before moving troops onto an airfield, obtain permission from airfield operations, and coordinate with designated airfield personnel who will provide guides or appropriate instructions. Troops are moved on the airfield in controlled formation only. Halt at least 100 feet from the edge of runways, taxi strips, and ramps, and get clearance before crossing.

FLIGHT LINE SAFETY

- Smoke only in designated areas.
- Do not walk in front of any aircraft when the engines are running, and never walk within the propeller arc at any time.
- Walk around the outside of the wing tips to avoid the auxiliary power units' blast or heat exhaust and the propeller or jet intake area.
- Speed limit for all vehicles on the flight line is 15 miles per hour.
- Speed limit for all vehicles within 50 feet of aircraft is 5 miles per hour. On loading ramps or inside the aircraft it is 3 mph (walking speed), and is under control of the loadmaster.
- When jet engines are running, do not approach within 50 feet of an engine intake nor within 200 feet of the blast area to the rear.
- Do not park closer than 25 feet to an aircraft.

- Do not drive a vehicle within 10 feet of an aircraft. This is called the “circle of safety,” and is designed to keep the aircraft from being damaged by vehicles.

**CIRCLE OF SAFETY**

- Do not allow trash or debris to be thrown on the flight line. Also, insure that canvas or small pieces of equipment are secure, to prevent the possibility of their being blown around by the jet exhaust.
- Do not stand or walk directly in front of or behind vehicles that are being driven or backed into the aircraft.
- Do not back vehicles toward or into an aircraft without spotters placed at the front corner and rear corner of the vehicle. Backing must be under the direction of a guide. Do not place spotters directly in front of or behind any moving vehicle.

IN-FLIGHT SAFETY

- Keep seat belts fastened when taking off or landing, and when ordered by the aircraft commander.
- Do not smoke unless allowed to do so by the aircraft commander. Smoking is prohibited when vehicles or hazardous cargo is aboard.
- Do not operate any electronic devices.
- In the event of an emergency, follow the instructions of the aircraft commander or his designated representative.

OFF-LOAD SAFETY

- When cargo is being off-loaded with the engine running, passengers will exit the aircraft first.
- Do not remove any restraint devices or start vehicles until instructed by the load master.
- When deplaning during an off-load with the engine running, move only in a straight direction perpendicular to the aircraft at least 50 feet before turning (150 feet from a C-5 aircraft).
- Follow the flight line safety rules mentioned above.

SUMMARY

Air transportation is the best method to support crisis situations which require a rapid response by armed forces. An adequate airlift capability provides the commander with flexibility and mobility which enable forces to be moved quickly over long distances. You should be aware of some general principles of air movement.

Unit movement by air is authorized by the Department of the Army. The movement directive, issued by DA, is the basic order that directs units to move. Deployment instructions, issued by Army major commands, provide specific guidance to the moving units.

To determine accurate aircraft requirements, consideration must be given to whether the air movement will be an administrative movement or a tactical one.

Safety is always a major factor in the successful accomplishment of an air movement.

CHAPTER 2

AIRCRAFT CHARACTERISTICS AND DATA

The air movement planner requires a great deal of information to do his job properly. Some of this information is available within your unit or from other Army sources, but information about Air Force and Civil Reserve Air Fleet (CRAF) aircraft is harder to find. The aircraft that will be used by Army units in a strategic deployment are complex, highly expensive, and available in very low numbers. To properly plan a unit move, it is vital that the Army planner have a working knowledge of the design characteristics and operational capabilities of every aircraft likely to be used in a strategic deployment.

This chapter provides the information about Air Force and CRAF aircraft that you will need to plan a unit move, as well as to plan the actual loading of the aircraft. The information in this chapter is the first step in your movement plan, and you will have to refer to it constantly when preparing and rehearsing that plan.

AIR FORCE AIRCRAFT

C-130

The C-130, popularly referred to as "Hercules," is a four-engine, turbo-prop, medium range assault transport. It is the oldest type of aircraft in the active Air Force, and has established a tremendous record and reputation as a dependable workhorse for the Army.

A letter suffix after the number designation, such as the "H" in C-130H, indicates model variations. The principal differences between models typically include engines, payload, and fuel capacity.

The C-130 aircraft is particularly suited for tactical air transport operations. These operations include parachute or air-landed assaults, air supply and delivery, and aeromedical evacuation.

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AIR FORCE AIRCRAFT

C-130

C-141A

C-141B

C-5A

CIVIL RESERVE AIR FLEET

LOAD PLANNING CRAF AIRCRAFT

B707

B747

DC-8

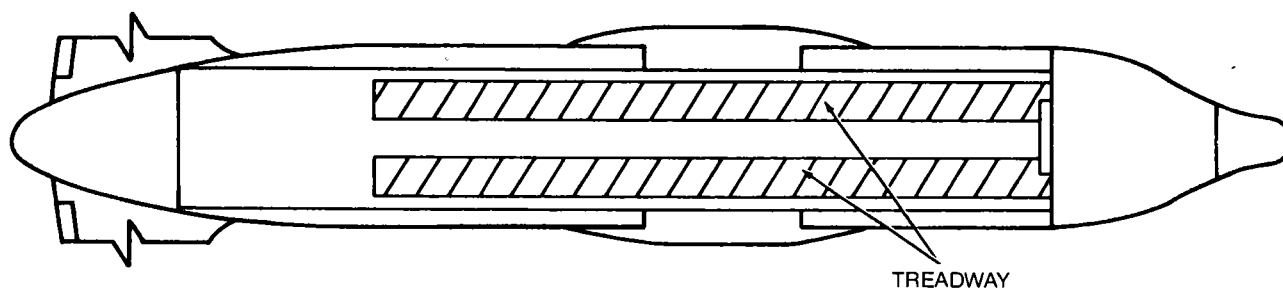
DC-10

L-1011

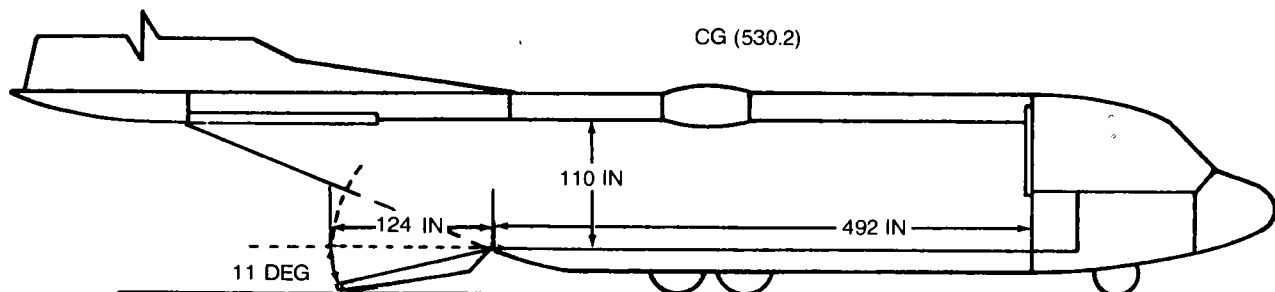
SUMMARY



C-130 HERCULES



CARGO COMPARTMENT OUTLINE



C-130 CHARACTERISTICS

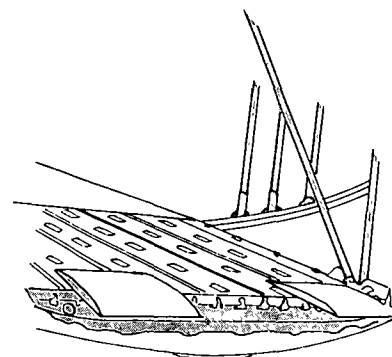
Nominal cruising speed (varies with models)	280 knots
Normal maximum authorized take-off weight	153,700 pounds
Normal maximum authorized landing weight	130,000 pounds
Emergency takeoff and landing weight	173,700 pounds
Ready-for-loading (RFL) weight*	129,000 pounds
Optimum center of gravity (CG), fuselage station	530.2
CG limits, station	525.2 to 535.1
Ramp	
Width	120 inches 3.048m
Length	120 inches 3.048m
Angle (slope to ground)	11.5 degrees
Troop door	
Height	72 inches
Width	36 inches
Cargo floor height (above ground level)	40 inches
Number of 463L pallets	6
Troop seats	
Passengers	92
Paratroopers	64
Cargo compartment dimensions	See illustration, page 2-2
Allowable cabin load (ACL)	25,000 pounds

*Total aircraft weight (including fuel and crew) without cargo, based on a 2,000-nautical-mile flight.

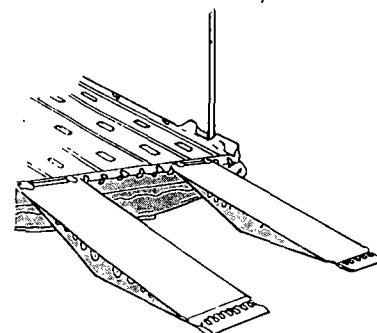
Loading Ramp and Loading Aids. For more convenient loading of the "Hercules," a number of aids are supplied with the aircraft or are available as options. These are stored in various places throughout the cargo compartment.

In addition to the primary loading aids illustrated to the right, the following aids are also available. All except the wheeled pry bars are provided in the aircraft.

- Wheeled pry bars for handling boxes and crates in the cargo compartment.



**AUXILIARY TRUCK-LOADING
RAMP (BRIDGE PLATES)**



**AUXILIARY GROUND-LOADING
RAMP (RAMP EXTENSION)**

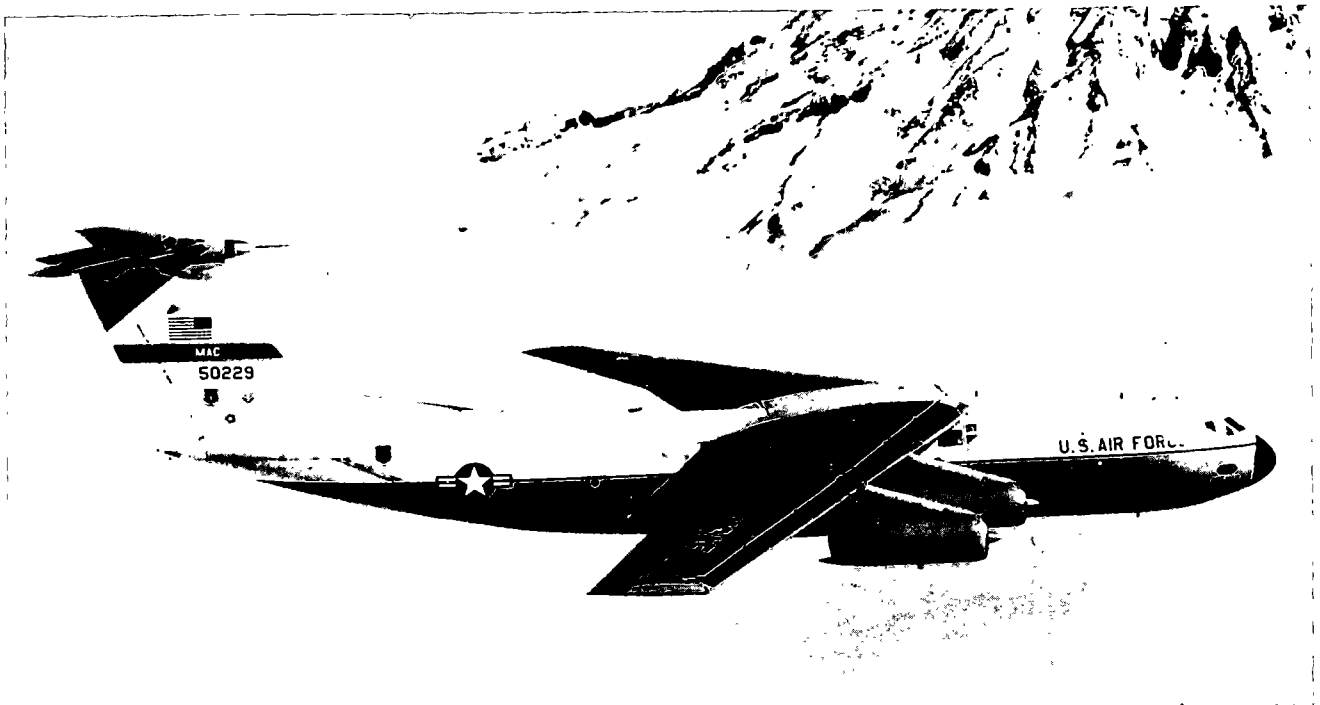
- Portable electric winch for moving cargo in and out of the aircraft.
- Internal electrical power outlets for using powered aids when loading the aircraft.
- An auxiliary power unit for electricity and hydraulic pressure to assist aircraft loading.
- A public address system consisting of loudspeakers, microphones, headsets, extension cords, etc., for giving loading instructions and controlling the loading operation.
- Lighting for cargo compartment and door area illumination during night loading.
- Snatch blocks (loading pulleys) to aid the moving of cargo in and out of the compartment. These loading pulleys may be screwed into any of the receptacles provided for the 25,000-pound tiedown rings.

C-141A

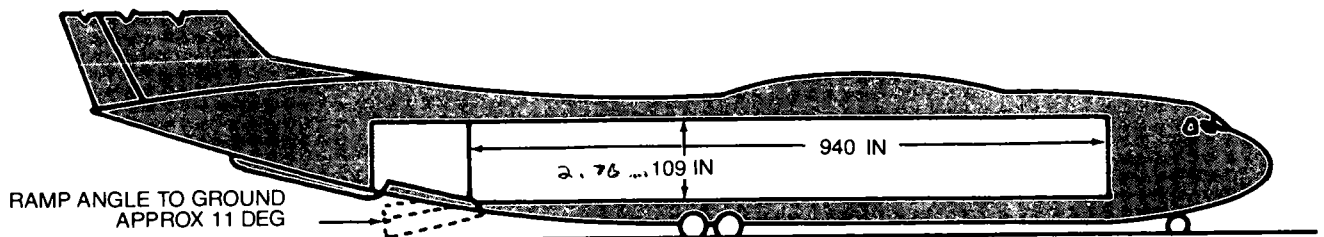
The C-141A "Starlifter" is a high-wing, four turbofan-engined, heavy transport airplane. Its mission is to transport cargo and personnel worldwide, and it may be used for aerial delivery. Features of this aircraft include crew and cargo compartment pressurization, and ground and in-flight air conditioning. The C-141 is the backbone of the strategic airlift capability of the US Air Force, and the aircraft you will most often use for all basic movement planning.

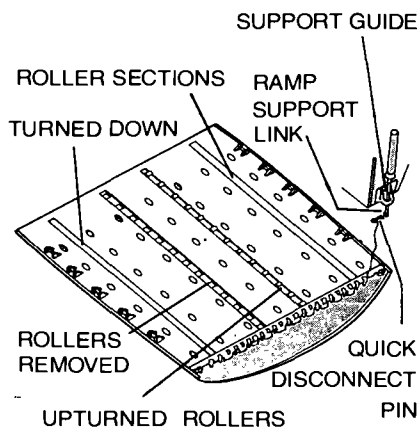
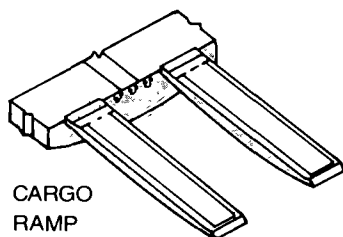
C-141A CHARACTERISTICS DATA

Cruising speed	440 knots
Normal maximum authorized take-off weight	323,100 pounds
Normal maximum authorized landing weight	257,500 pounds
Ready-for-loading (RFL) weight*	233,000 pounds
Optimum center of gravity (CG), fuselage station	932.0
CG limits, station	917.4 to 946.6
*Total aircraft weight (including fuel and crew) without cargo, based on a 2,000-nautical-mile flight.	

**C-141A STARLIFTER**

Ramp	Width	133.25 inches	3.38 m
	Length	123.25 inches	3.13 m
	Angle (slope to ground)	11 degrees	
Troop door	Height	72 inches	
	Width	36 inches	
Troop seats	Passengers (normal)	102	
	Passengers (max)	152	
	Paratroopers (normal)	104	
	Paratroopers (max)	122	
	With cargo configured aircraft	70	

CARGO COMPARTMENT

**INTEGRAL CARGO RAMP****AUXILIARY GROUND
LOADING RAMPS****C-141 CARGO RAMP**

Cargo floor height (above ground level)	50 inches
Number of 463L pallets	10
Litters	80
Cargo compartment length (usable)	940 inches. See illustration, page 2-5.
Allowable cabin load (ACL)	60,000 pounds

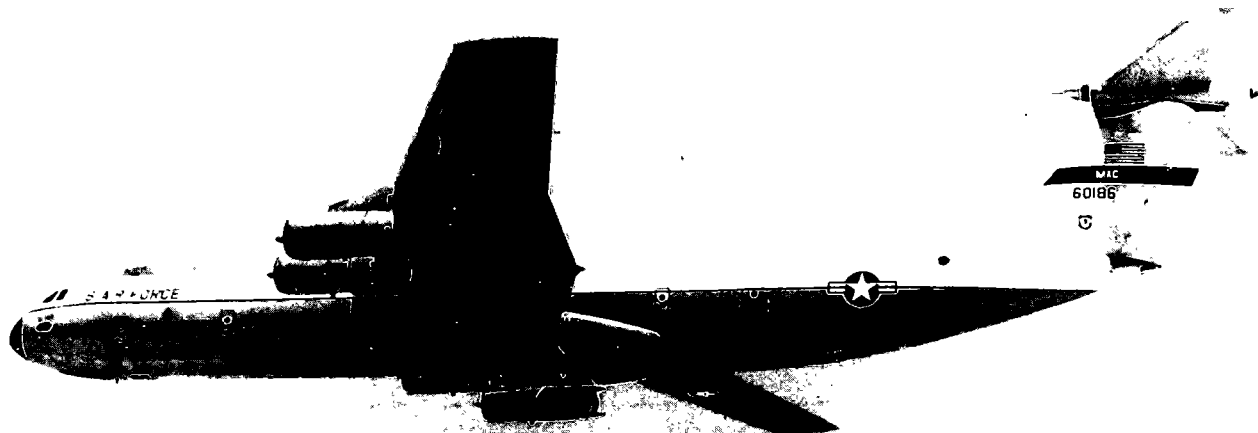
Cargo Compartment Load Capacities and Weight Limits. As is the case with all Air Force aircraft, the C-141A cargo compartment weight limits are not constant for every place throughout the aircraft floor. The treadway is far stronger than the flooring between the treadway strips, and different sections of the treadway have different weight limits. The loading of very heavy vehicles may have to be coordinated with your affiliated airlift unit or airlift control element (ALCE) to ensure that the aircraft limits are not exceeded.

C-141B

The C-141B "Starlifter" is a high-wing, four turbofan-engine-powered heavy transport airplane. It is a rebuilt C-141A with a 23-foot (276-inch) longer fuselage and provision for air-to-air refueling. Its mission is the same as that of the C-141A, which it will entirely replace beginning in 1981. All other features and equipment listed for the C-141A are also applicable to the C-141B.

C-141B CHARACTERISTICS DATA

Cruising speed	440 knots
Maximum authorized take-off weight	323,100 pounds
Maximum authorized landing weight	257,500 pounds
Ready-for-loading (RFL) weight	240,000 pounds
Optimum center of gravity (CG), fuselage station	932.0
CG limits, station	899.8 to 946.6
Ramp Width	123.25 inches
Length	133.25 inches
Angle (slope to ground)	11 degrees



Troop door	Height	72 inches
	Width	36 inches
Cargo floor height (above ground level)		50 inches
Number of 463L pallets		13
Troop seats	Passengers (normal)	125
	Passengers (maximum)	208
	Paratroopers (normal)	128
	Paratroops (maximum)	155
	With cargo configured aircraft	100
Litters		103
Cargo compartment length (usable)		1220 inches
Allowable cabin load (ACL)		72,900 pounds

C-141B STARLIFTER

C-5A

The C-5A "Galaxy" is a swept wing, long-range, heavy lift, transport airplane. It is powered by four turbo-fan engines, rated at 41,100 pounds of thrust each. Its mission is to provide strategic airlift for heavy or outsized cargo vehicles and equipment. Typical features of this aircraft are the forward cargo door (visor) and ramp, and the aft cargo door system and ramp.

The front and rear loading ramps permit loading and off-loading of cargo from either end of the airplane. This design also permits vehicles to drive through the entire length of the cargo compartment. Deploying units can drive their equipment into the aircraft from the rear when loading. Upon arrival at the objective area, the nose visor can be raised, the ramp extended, and the vehicles driven off straight ahead.

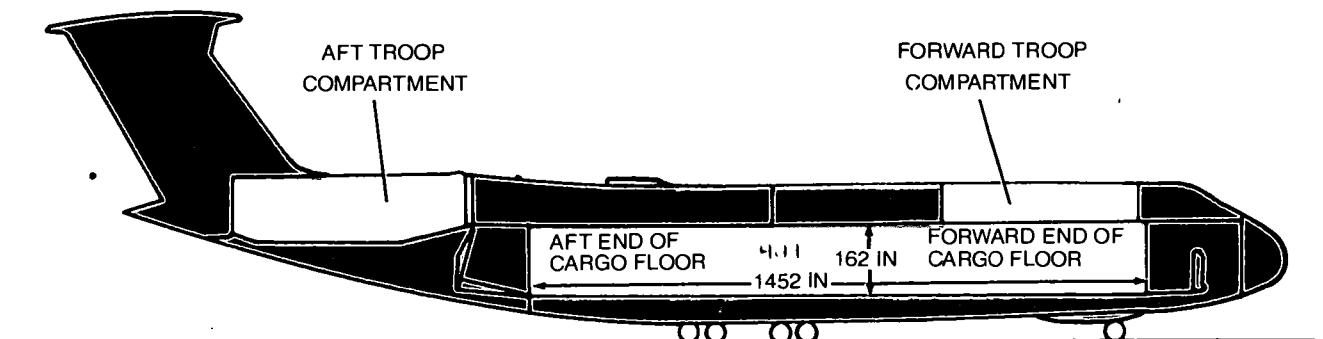
C-5A CHARACTERISTICS DATA

Cruising speed	440 knots
Maximum authorized take-off weight	712,500 pounds
Maximum authorized landing weight	635,850 pounds
Ready-for-loading (RFL) weight*	488,500 pounds
Optimum center of gravity (CG), fuselage station	1369.1
CG limits, station	1332.0 - 1406.2
Ramp (front) Width	228 inches
Length	116 inches
Ramp (aft) Width	228 inches
Length	155 inches
Troop door Height	72 inches
Width	36 inches
Loading ramp height (above ground level)	Variable
Front	36 to 53 inches
Aft	36 to 114 inches
*Total aircraft weight (including fuel and crew) without cargo, based on a 2,000-nautical-mile flight.	

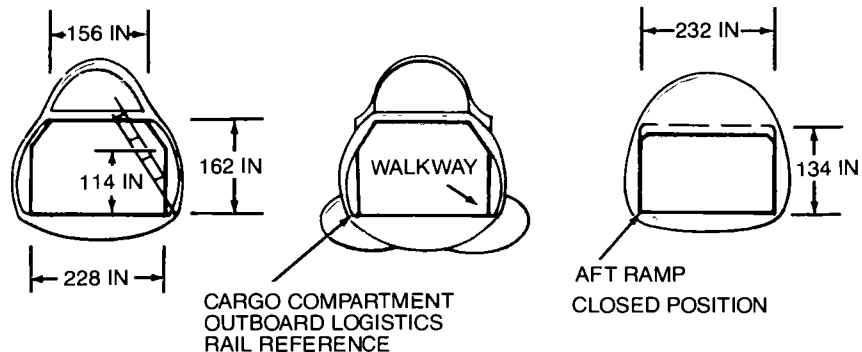


C-5A GALAXY

CARGO COMPARTMENT



C-5A AIRCRAFT SECTIONS

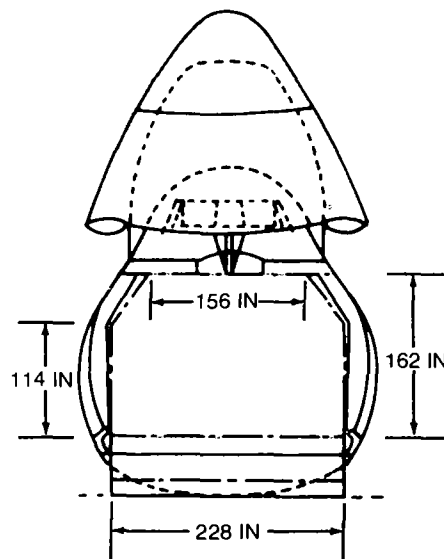
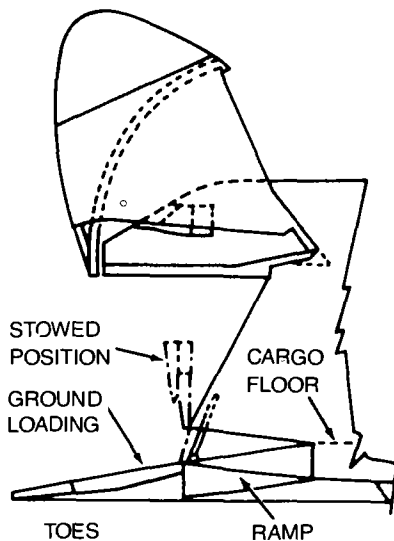


Cargo floor height (above ground level)	Variable
Front	58 to 71.5 inches
Aft	62 to 114 inches
Number of 463L pallets	36
Troop seats	
Passengers (normal)	73
Passengers (contingency)	328
Cargo compartment length (usable)	1453 inches
Allowable cabin load (ACL)	See page 2-12.

Cargo Compartment. The cargo compartment size, geometry, and payload capability have been optimized for the deployment of equipment and troops. The compartment is equipped with a forward cargo door (visor) and ramp and an aft cargo door system and ramp. The visor door, when closed, forms the nose of the aircraft. The forward ramp extension is stowed in the vertical position when not in use. The aft pressure door, which is also used as a ramp extension, may be raised to a horizontal position to permit airdrop operations.

Forward Cargo Opening. The illustration on the next page shows the details of the forward cargo opening with the visor in the raised position. The side profile of the cargo floor shows the ramp in the ground loading position and in the stowed position. The front view of the cargo opening shows detailed dimensions of the opening.

VISOR RAISED POSITION

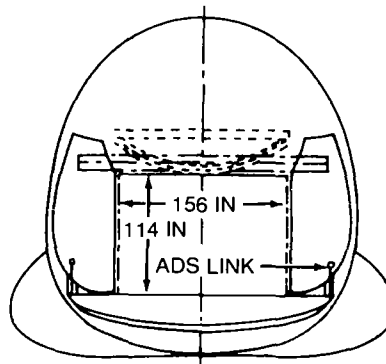
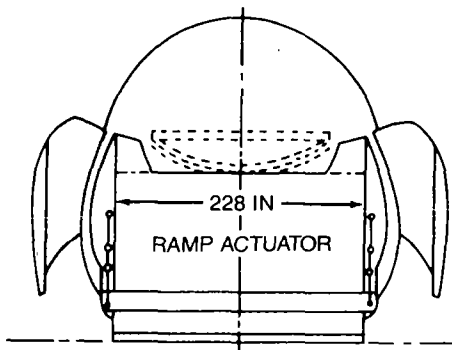


FORWARD CARGO OPENING

Aft Cargo Opening. Ground loading or unloading of vehicles is accomplished by hinging the pressure door to the ramp as a ramp extension, and lowering it to contact the ground. For air-drop there is an opening 13 feet wide and 9.5 feet high.

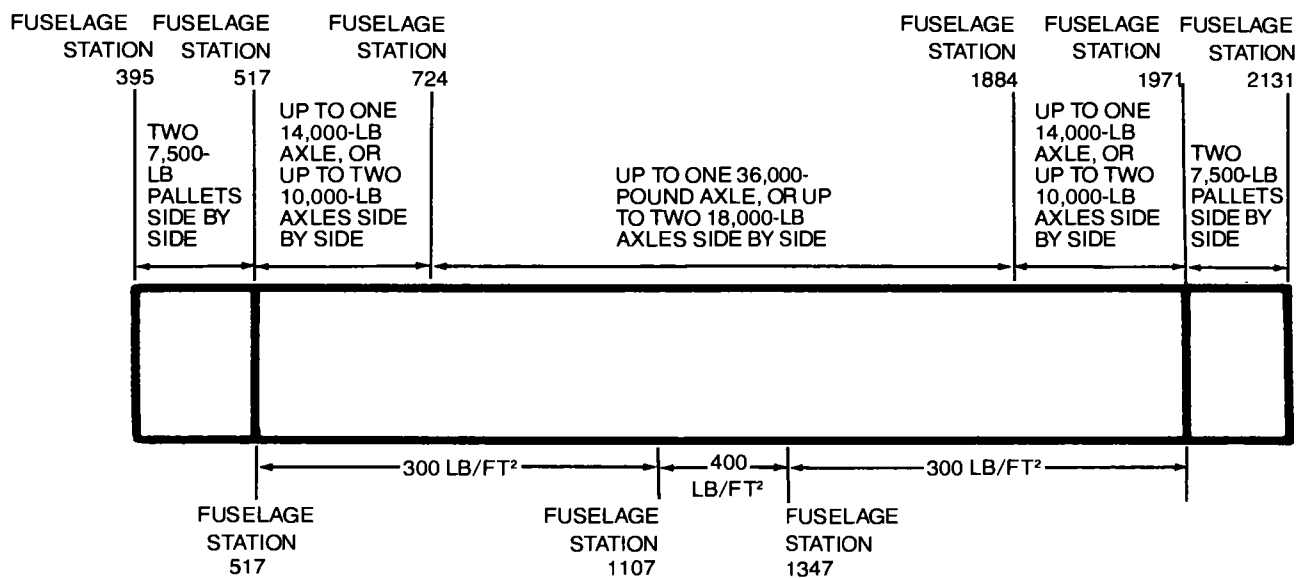
GROUND LOADING

AERIAL DELIVERY



AFT CARGO OPENING

Cargo Compartment Load Capacities. The cargo floor is a load-carrying structure across its whole width. This permits vehicles to traverse its whole area and to maneuver freely during loading operations. In flight, single 36,000-pound-axle loads, or two 18,000-pound axles side by side, may be carried in the area between fuselage station 724 and fuselage station 1884. The illustration also shows the in-flight loads in other floor areas and on the ramps, as well as the distributed loads in pounds per square foot. The capability of the ramps and floor are such that tanks and other tracked vehicles weighing as much as 129,000 pounds can be loaded and transported.

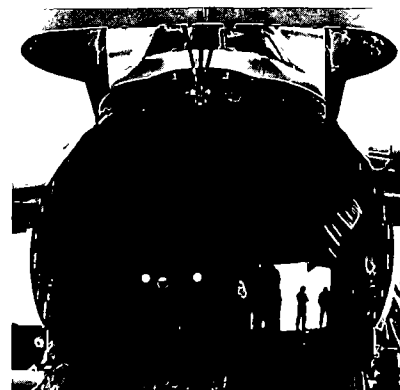


IN-FLIGHT FLOOR LOADING

For general cargo and vehicular tie-down provisions, the cargo floor has 304 flush, permanently installed rings, each capable of sustaining a design limit load of 25,000 pounds. The tie-down rings are designed to receive either one hook from a 25,000-pound restraint device or two hooks from 10,000-pound restraint devices.

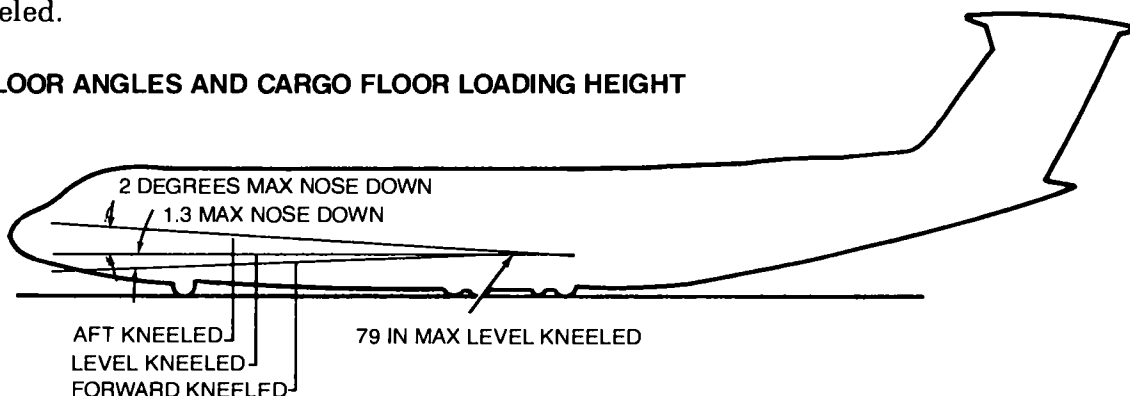
Kneeling Capability. Another feature of the airplane that facilitates and expedites loading and off-loading operations is its capability to kneel. Kneeling of the landing gear permits the cargo compartment floor to be lowered approximately 3 feet to 52 to 71 inches above the ground. This kneeling feature was incorporated for two reasons: to facilitate loading operations by lowering the cargo ramps for truck-bed and ground loading, and to reduce the ramp angles for the loading and off-loading of vehicles.

The illustrations show cargo floor angles and ramp angles for the kneeling condition. The C-5A is also shown nose up when aft-kneeled, nose down when forward-kneeled, and level when level-kneeled.

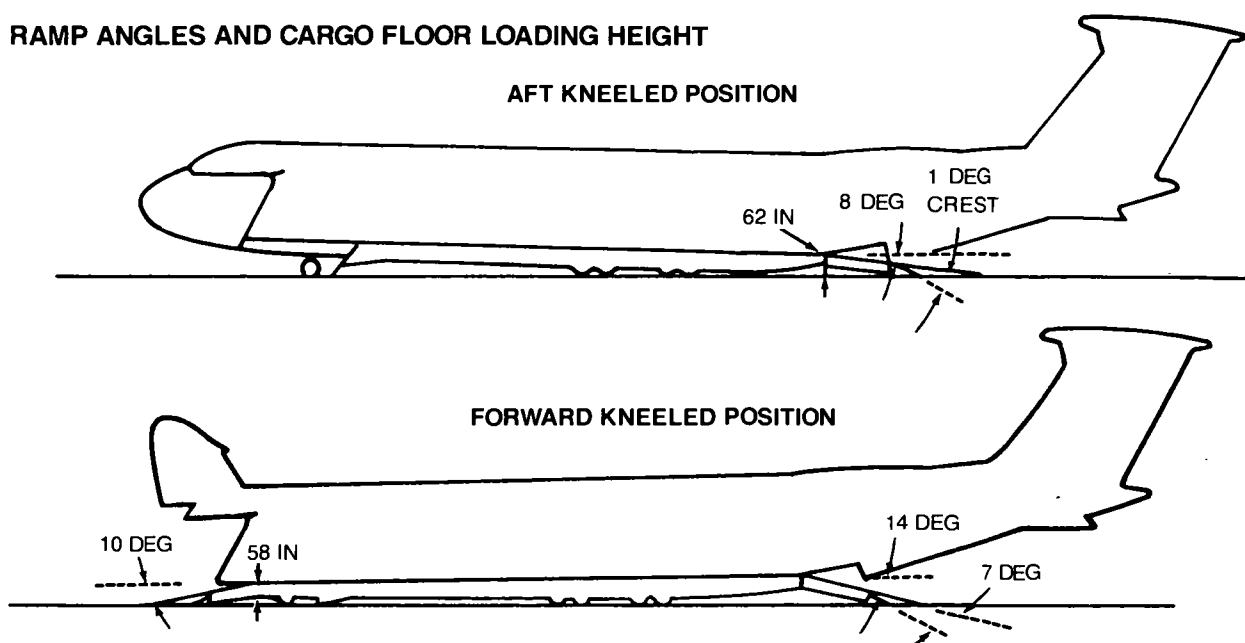


C-5A KNEELING

CARGO FLOOR ANGLES AND CARGO FLOOR LOADING HEIGHT



RAMP ANGLES AND CARGO FLOOR LOADING HEIGHT



CIVIL RESERVE AIR FLEET (CRAF) AIRCRAFT CHARACTERISTICS

Use of the Civil Reserve Air Fleet aircraft will become an increasingly important part of movement planning. The use of civil aircraft will be necessary for the success of the strategic deployment mission in a national emergency. When fully activated, the CRAF will include half of all airlift available for the deployment of US forces to a theater of operations.

Aircraft for the CRAF are supplied by US civil air carriers under an agreement with the Department of Defense. They can be activated by the President or Secretary of Defense under the declaration of a national emergency. The CRAF aircraft will be operated by their civilian aircrews under the command and control of the Military Airlift Command (MAC). Employment and operational planning for utilization of the CRAF is a responsibility of MAC. MAC also administers the annual airlift services contract and determines the suitability of aircraft for CRAF participation.

LOAD PLANNING FOR CRAF AIRCRAFT

Although the general principles for planning and executing the loading of civilian aircraft are the same as for military aircraft, there are so many differences that the task should not be accomplished without the close supervision of the MAC ALCE representative. The aircraft in the CRAF are provided from different civil air carriers, who have had the aircraft built to their own specifications and needs. All the CRAF aircraft will need some modification before military vehicles and equipment can be loaded on them.

For many units, it is **more** likely that you will use a civilian aircraft for strategic deployment than a military aircraft. In the event of a national emergency, airlift will be in very short supply, and Air Force aircraft will have to be used to carry large vehicles and equipment. You will have to plan maximum utilization of the civilian aircraft just as you would the military aircraft. The B747, for example, can carry almost as much in its lower lobe compartments as an entire C-141A. Loading of these compartments must be planned for the most effective use of available airlift resources.

There are problems associated with loading a CRAF aircraft that are not usually encountered in loading military aircraft. The

cargo compartment of a B747, for example, is 16 feet above ground level (AGL), so standard military material handling equipment cannot be used to load the aircraft. In all cases, the floors of the civilian aircraft are not strong enough to withstand the ground pressure of vehicles, so a subfloor of 463L pallets will have to be installed prior to loading any vehicles. Even then, any vehicle heavier than a 2½-ton truck cannot be loaded onto most civilian aircraft. Some pallet stations also have weight restrictions; see the individual aircraft floor plans for planning weight limits for each fuselage station.

The roller/restraint systems in most civilian aircraft will accept a military 463L pallet, but on most of those aircraft the rails will have to be moved before the pallets can be loaded. Height restrictions are also critical. You will not be able to make all your pallet loads the same height due to differences in fuselage configurations. This is especially true of the lower lobes in the wide body aircraft. Study the fuselage cross sections in this section of the manual before planning pallet loads on civilian cargo aircraft.

Another restriction is the width of the cargo doors. Except for some B747 models, you will not be able to drive straight onto the aircraft, as the doors on the fuselage sides are relatively small.

Restraining cargo once it is aboard the aircraft is another problem. When a pallet subfloor is installed prior to the loading of military vehicles, you will have to apply the tiedown devices in accordance with the limits of the pallet. The restraint criteria for civilian aircraft are different than for Air Force aircraft (see also chapter 4):

- Forward: 1.5 times the force of gravity (g)
- Aft: 1.5g
- Vertical: 2.0g
- Lateral: 1.5g

Since the rings on a 463L pallet are too small to accept an MB-2 tiedown device, you will have to restrain your vehicles with MB-1 and CGU-1/B devices only.

In spite of the loading problems they present, CRAF aircraft are a necessary part of your airlift planning. The aircraft characteristics table and the planning data given in this manual for each civil aircraft should make your planning effort easier. The use of civil aircraft must be closely coordinated through your affiliated MAC ALCE.

B707

The B707 is a four-engine, long-range, narrow-body aircraft.

The B707 can carry approximately 60,000 pounds of cargo or 165 passengers.

The main deck of the B707 can carry 13 military or commercial pallets. Military and commercial pallets can be mixed in the same load. When 108-inch pallets are to be loaded, a flip-up rail 17 inches from the left side cargo rail is positioned to receive the pallet. The aft-most pallet must face with the 88-inch side facing the front/aft section of the cargo compartment.

All military cargo on the main deck will be palletized or loaded on a palletized subfloor.

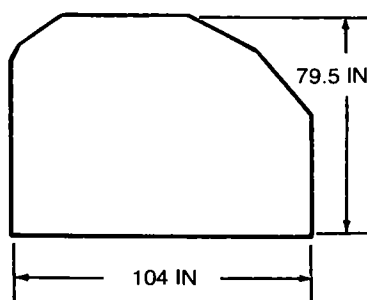
The side door to the main deck is approximately 10 feet AGL; therefore, items can be loaded with standard military materials handling equipment (MHE) (except the TAC loader).

The lower deck has a forward compartment and an aft compartment. There is one door into the forward compartment, and there are two doors into the aft compartment.

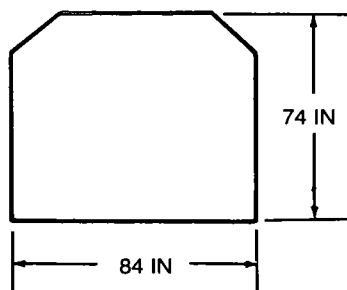
Because of the door size, pallets cannot be used as a subfloor; therefore, the lower compartments normally are used for baggage or small cargo items where a subfloor is not required.

NOTE: The B707 can settle on its tail section if improperly loaded. The forward section of the main cargo compartment and the lower forward compartment will be loaded before the aft section.

As is the case with most commercial aircraft, it is preferable to load the lower lobe forward compartment before loading the aft compartment. If there is a notable weight difference, the heavier cargo should be placed in the forward compartment.

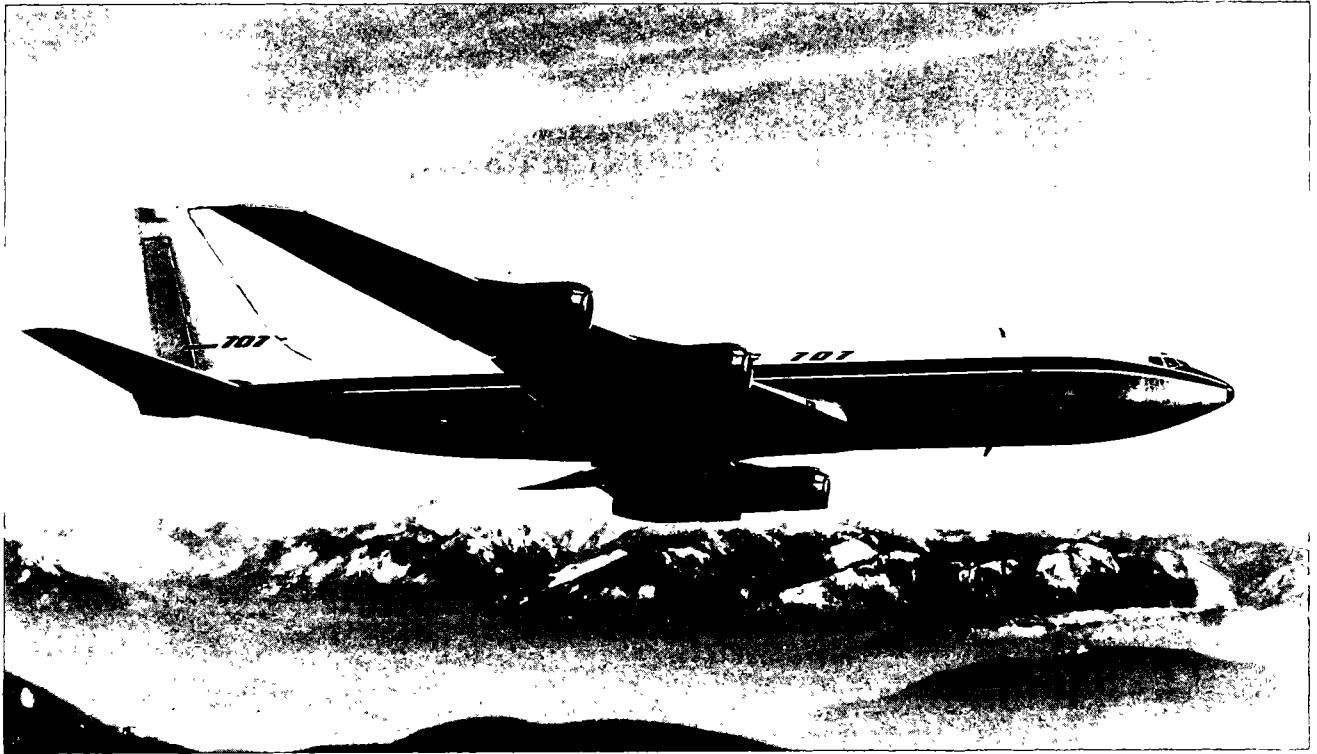


POSITIONS 1 THRU 12

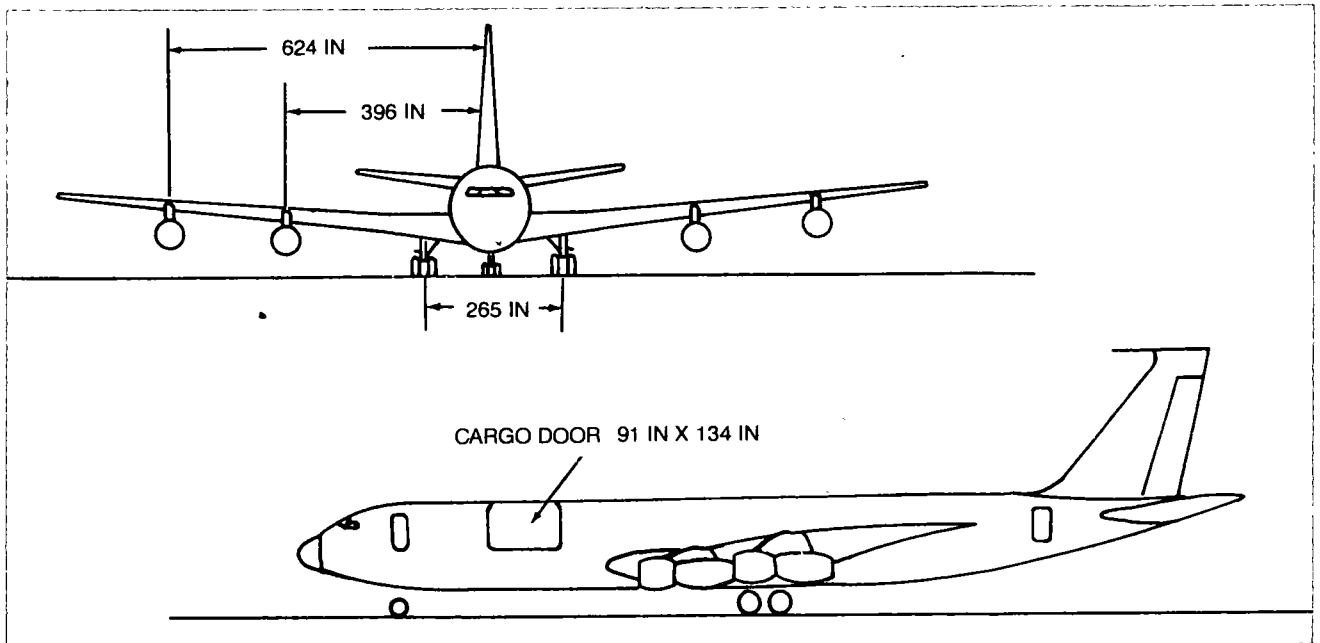


POSITION 13

CRAF PALLET PROFILES
(SEE APPENDIX D FOR DETAILS)



BOEING B707



B747

The cargo-carrying versions of the B747 have an average planning cargo weight of approximately 180,000 pounds, or can carry approximately 364 passengers (266 passengers for the B747 SP).

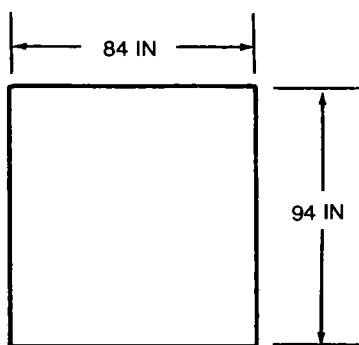
The main deck of the B747 can hold either 33 or 37 military pallets or 28 commercial pallets. The aircraft has an optional pallet position in the extreme aft section of the main deck. Use of a planning figure of 33 pallet positions for the main deck is recommended.

All military cargo on the main deck will be palletized or placed on a palletized subfloor.

The B747-100F has side door only loading to the main cargo area. The B747-200C may have visor door only loading, or both visor and side door loading, to the main deck; the B747-200F has both nose and side door loading. The visor and side doors are approximately 16 feet AGL, and thus require other than standard military MHE.

The upper area directly behind the crew compartment may be included for military planning purposes for passengers on a select basis.

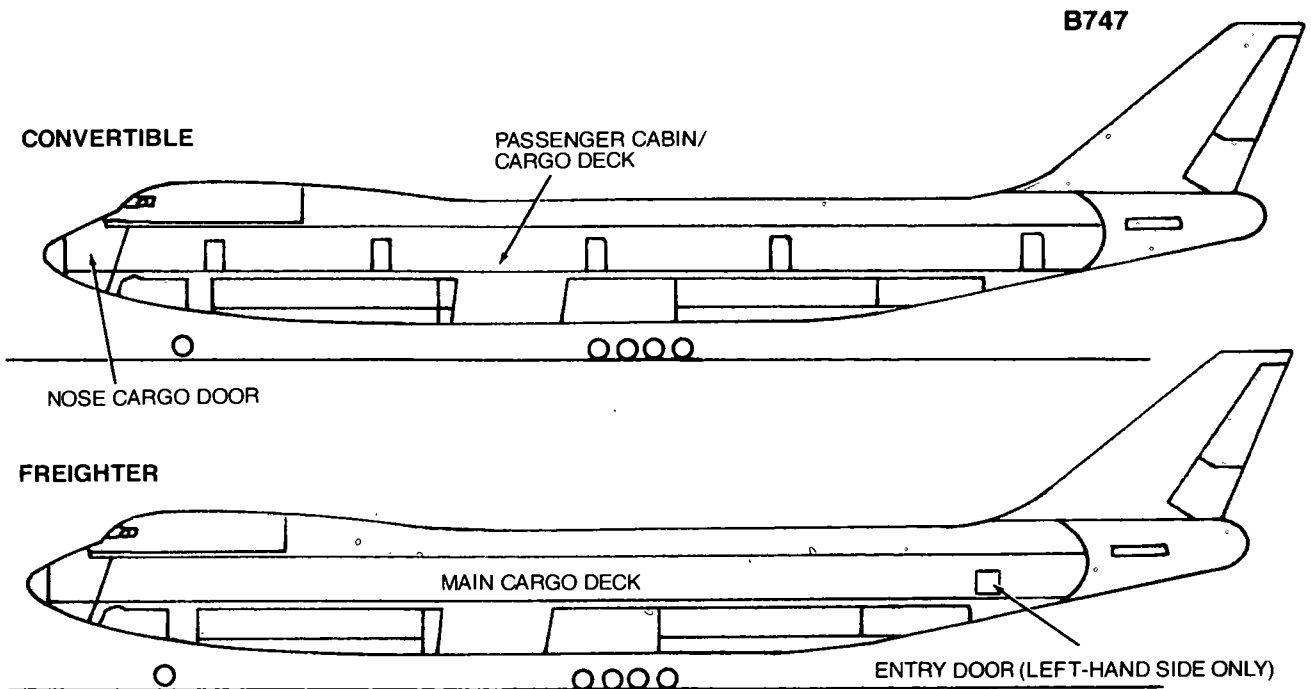
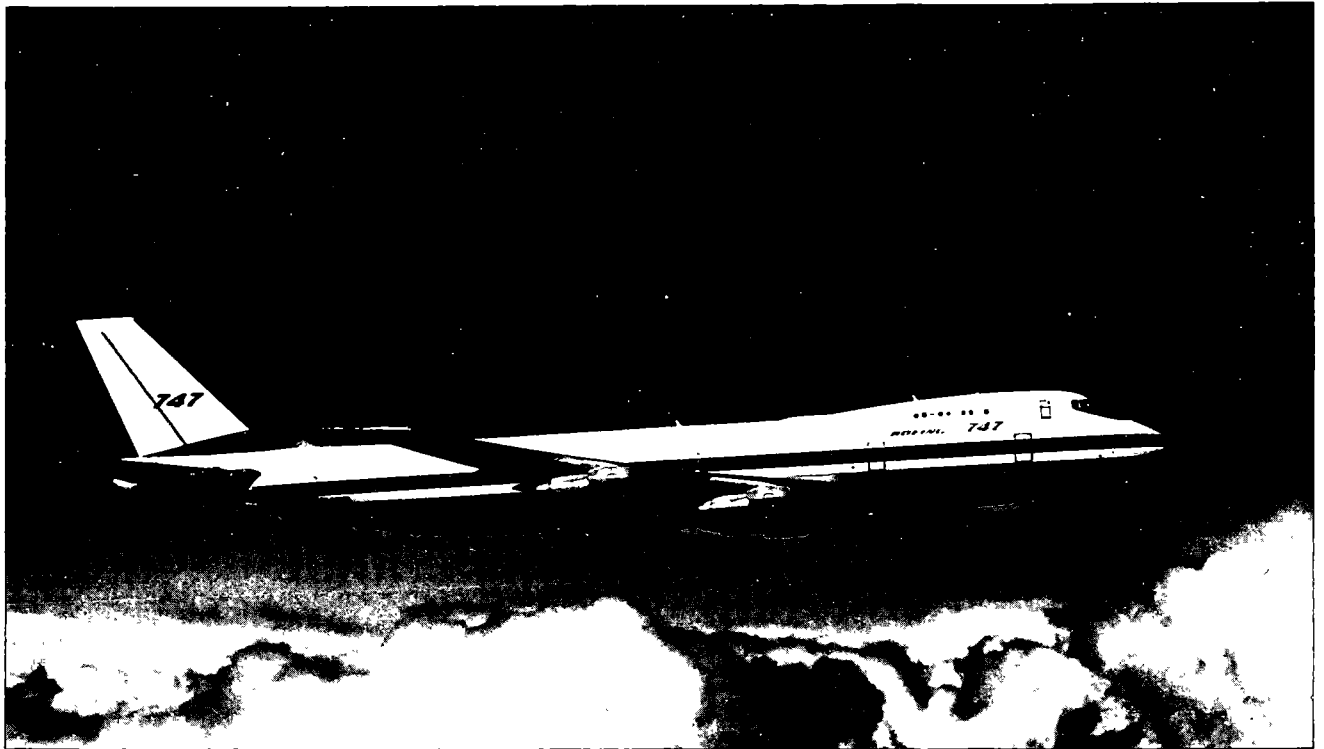
The lower deck or lobe has three sections. The forward lower lobe can carry five military or commercial pallets, a center lower lobe can carry four military or commercial pallets, and a lower lobe aft bulk area can carry approximately 800 cubic feet of bulk cargo. The lower lobes can also carry eight full-sized cargo containers (186 by 60.5 by 64 inches) in the forward section, and seven in the aft section.



B747 PALLET PROFILE

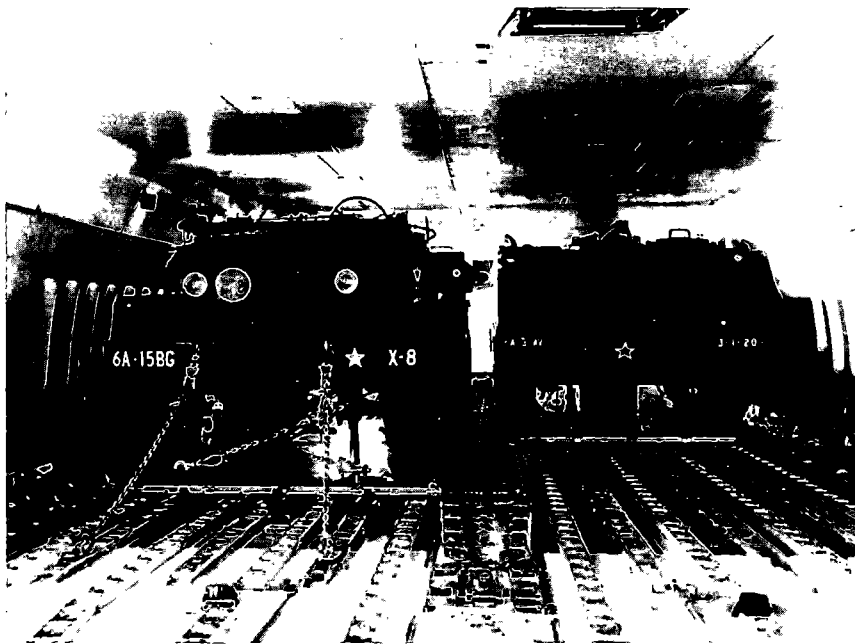
NOTE: Cargo capabilities vary; refer to the specific aircraft series.

For the forward and aft lower lobes, cargo must be palletized, put on a pallet subfloor, or containerized. The bulk area normally is used for baggage or light cargo, and therefore would not require a subfloor. A removable net separates the bulk cargo area from the lower lobe aft compartment.



The lower lobes normally have rails ready to accept a commercial pallet. If hardware is not available to convert the rails to accept a 463L pallet, provide lateral restraint by securing the pallet with a chain bridle to the left rail. Secure with straps or chains. Forward or aft and vertical restraint is provided by end locks.

**MILITARY VEHICLES IN
BOEING 747**



DC-8

The DC-8 is a four-engine, long-range, narrow-body aircraft.

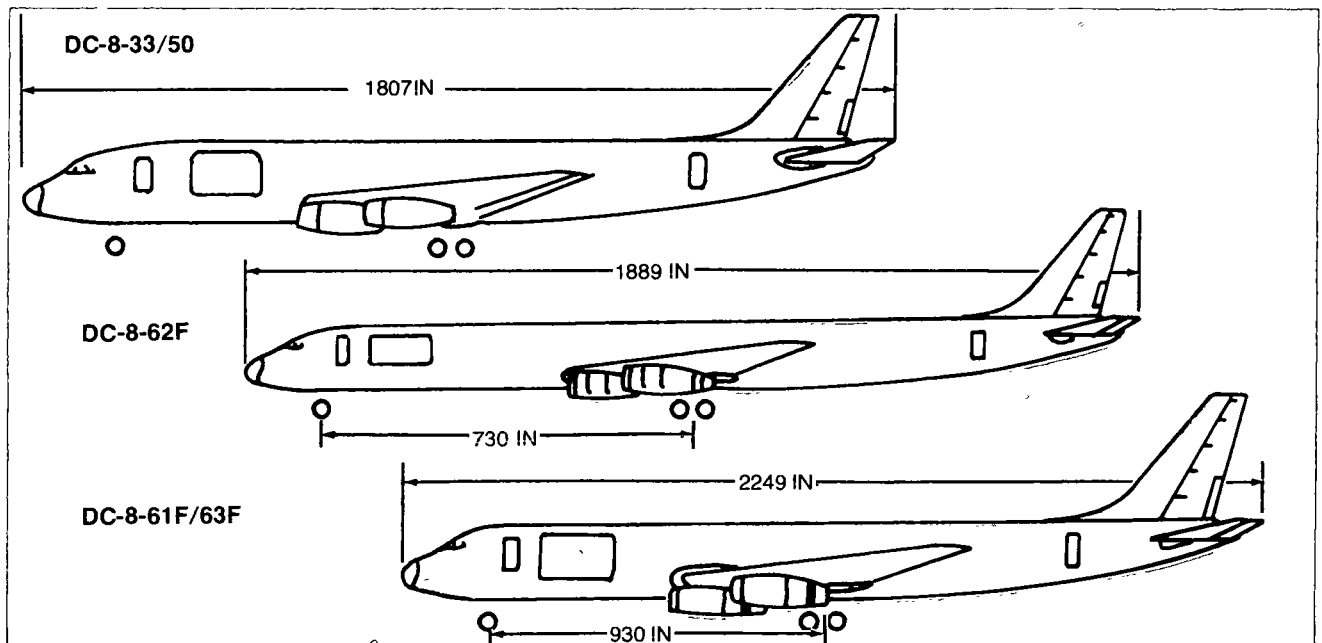
The cargo-carrying versions have a planning cargo weight that varies from 52,000 to 82,000 pounds. Passenger versions vary from 170 to 251 seats.

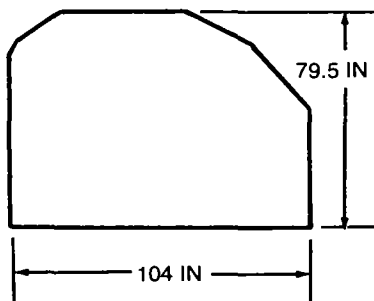
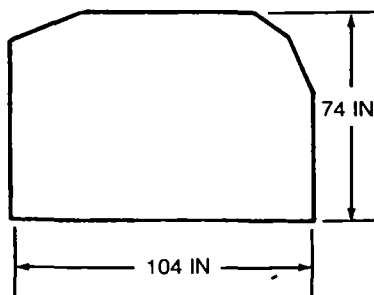
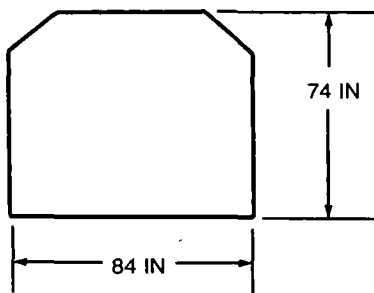
The main deck of the DC-8 can receive from 13 to 18 pallets, depending on the aircraft series.

The aircraft rail system is capable of accepting 125 inch-wide commercial or 108 inch-wide military pallets. Both side cargo rails may be moved inboard 8.5 inches to allow for centerline loading of the 108 inch military pallet. The rail system is not capable of accepting the military 463L pallet and the 125 inch commercial pallet in the same load. The aft-most pallet must face with the 88-inch side facing the front or aft section of the cargo compartment.



McDONNELL DOUGLAS DC-8





DC-8 PALLET PROFILES

All military cargo on the main deck should be palletized or placed on a palletized subfloor.

The side door to the main deck is approximately 11 feet AGL; therefore, items can be loaded onto the main deck with standard military MHE (except the TAC loader).

The lower deck has a lower forward compartment, and a lower aft compartment. There is no aft bulk cargo area. The size of the compartments varies according to series. The forward and aft lower compartments all have two cargo doors into each compartment with the exception of the DC-8-33, which has only one door to each compartment.

Because of door restrictions, pallets cannot be used as a subfloor; therefore, the lower compartments normally are used for baggage or small cargo items.

NOTE: The DC-8 can settle on its tail section if loaded improperly. Prior to loading the main cargo compartment, approximately 5,000 pounds of cargo should be positioned in the forward area of the main deck, pallet position 1, or in the forward lower compartment.

As with most commercial aircraft, it is preferable to load the lower forward compartment before loading the aft compartment. If there is a notable weight difference, the heavier cargo should be placed in the forward compartment.

DC-10

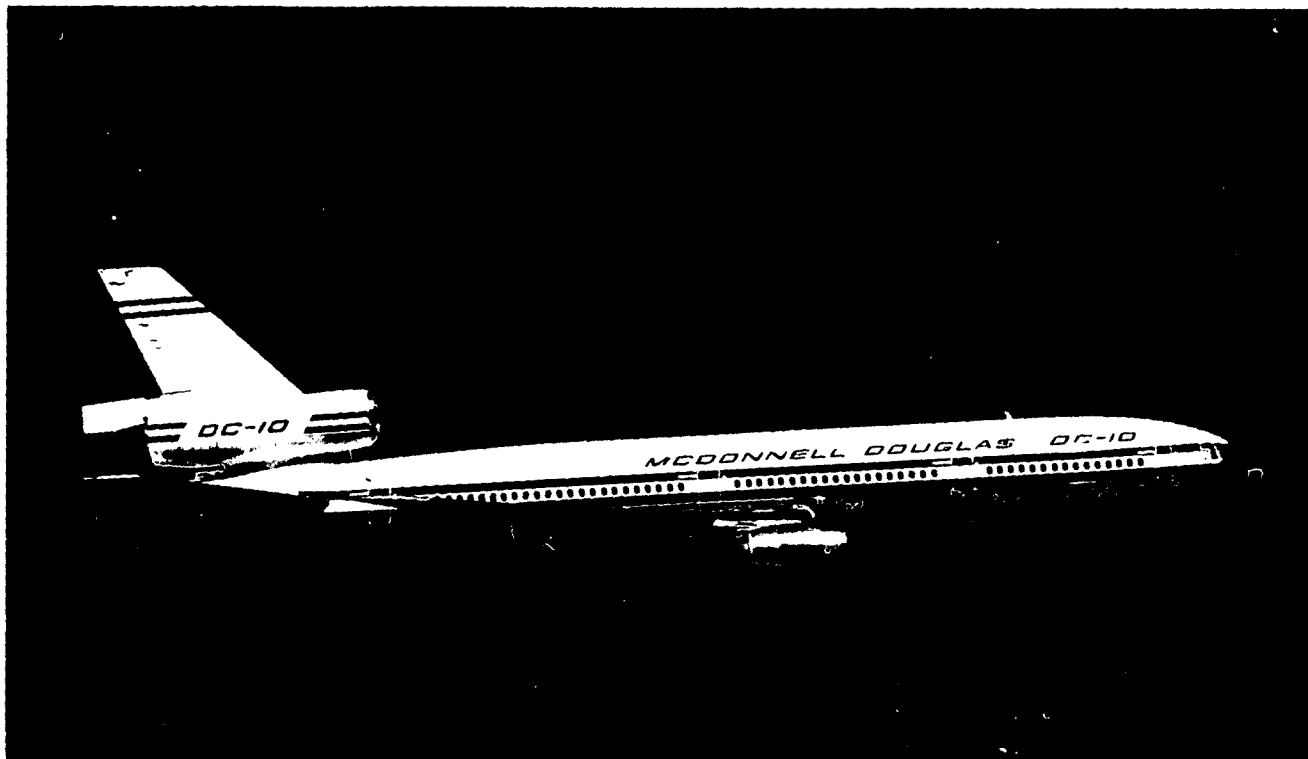
The DC-10 is a wide-body aircraft.

The cargo-carrying versions have an average cargo-carrying weight of approximately 120,000 pounds; this version will carry approximately 242 passengers.

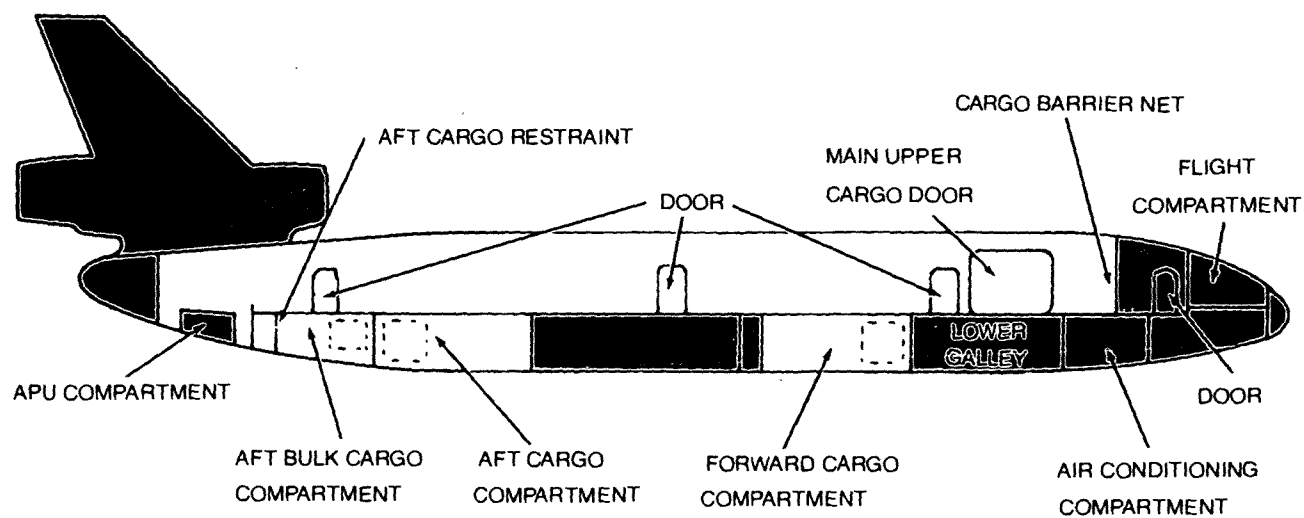
The main deck of the DC-10 can hold either 30 military or 22 commercial pallets.

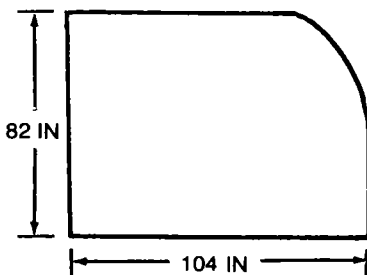
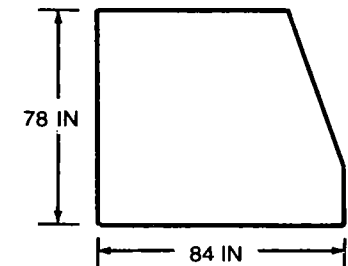
All military cargo on the main deck normally is palletized or placed on a palletized subfloor.

The side door to the main deck is approximately 16 feet AGL, and therefore requires other than standard military MHE.



MCDONNELL DOUGLAS DC-10





**DC-10-10/30CF
PALLET PROFILES**

The lower deck has a lower lobe forward compartment that can hold five military or commercial pallets (two in the DC-10-30CF), a lower lobe aft section that can hold two military or commercial pallets, and a lower lobe aft bulk compartment that can hold approximately 700 cubic feet of bulk cargo.

Because of the door size, all pallets must be tilted through the doors of the lower lobes. (Exception: The DC-10-10F and DC-10-40 lower lobe forward compartment forward door will accept a pallet without its being tilted.)

The lower lobe forward compartment for the DC-10-30CF has a permanently installed galley area that permits loading in the aft two pallet positions only.

For the forward and center lower lobe compartments, cargo normally is loaded onto a palletized subfloor. The bulk area normally is used for baggage or light cargo, and therefore would not require a subfloor.

The lower lobes normally have rails ready to accept a commercial pallet. If hardware is not available to convert the rails to accept a 463L pallet, lateral restraints must be provided by securing the pallet by attaching a chain bridle to the left rail, and securing the straps or chains. Forward or aft and vertical restraint is provided by end locks.

The DC-10 must be loaded from the aft forward.

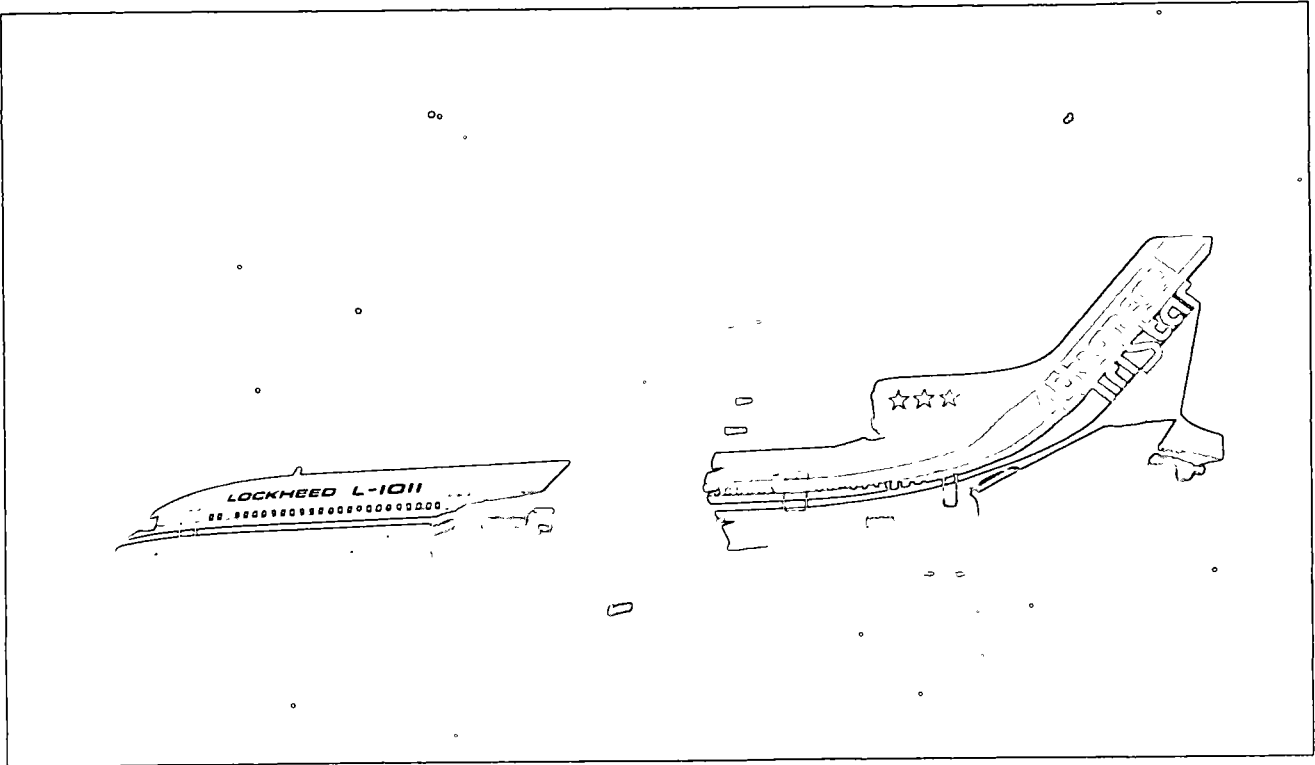
L-1011

The L-1011 is a three-engine, long-range, wide-body passenger aircraft.

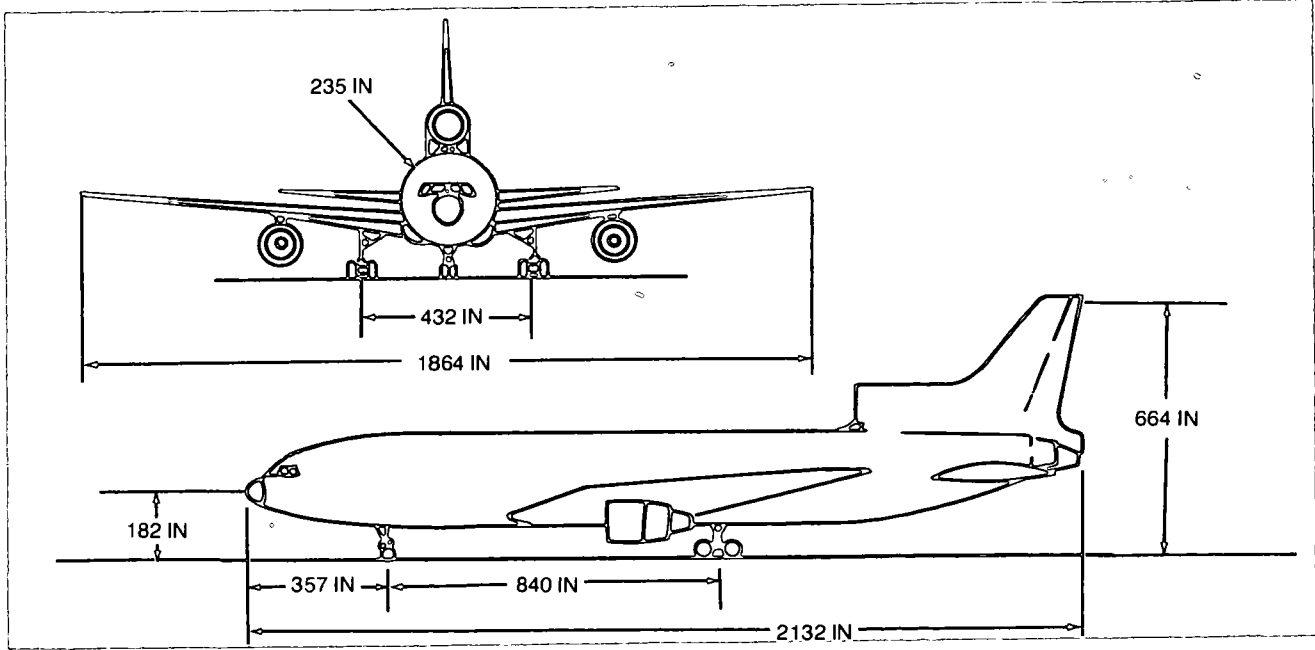
The only aircraft now available for military use is the passenger model. Depending on the series, the main deck can carry a maximum of 330 passengers.

The lower lobe has a forward compartment with a single door; center compartment with a single door; and an aft bulk loading compartment, also with a single door.

The L-1011-100 has the galley either in the lower lobe or in the main deck cabin. Pallets can be placed in the lower lobe, forward compartment, if the galley is in the main deck. The door size restricts pallets in those aircraft with a galley in the lower lobe. Because of door size restrictions, pallets cannot be placed either in the center compartment or in the aft bulk area.



LOCKHEED L-1011



NOTE: The L-1011 can settle on its tail section if improperly loaded. The forward section of the main cargo compartment and/or the lower lobe forward compartment should be loaded before the aft section.

As is the case with most commercial aircraft, it is preferable to load the lower lobe forward compartment before loading the aft compartment. If there is a notable weight difference, the heavier cargo should be placed in the forward compartment.

SUMMARY

The C-130 "Hercules," the C-141A "Starlifter," and the C-5A "Galaxy" are extremely versatile transport aircraft which well meet the Army's capability requirements for speedy airlift of personnel and equipment to any location in the world.

Each of the aircraft has peculiar and special characteristics with which you must be familiar before planning a unit movement by air.

- The C-130 assault transport can deliver personnel and cargo close to the battlefield. It can operate out of unimproved field strips and can be used for assault airland or airdrop operations.
- The C-141 jet-powered heavy transport is the backbone for strategic airlift operations, including airborne assaults. It is the primary aircraft you should expect for air movement planning.
- The C-5A is the heavy equipment lifter with aerial refueling capability, capable of reaching any point in the world. You should plan to use the C-5 **only** for outsized or overweight vehicles, because of the relatively few numbers of these aircraft.
- CRAF aircraft are commercial international transports without any special military equipment. They are used to supplement Air Force aircraft in time of national emergency.

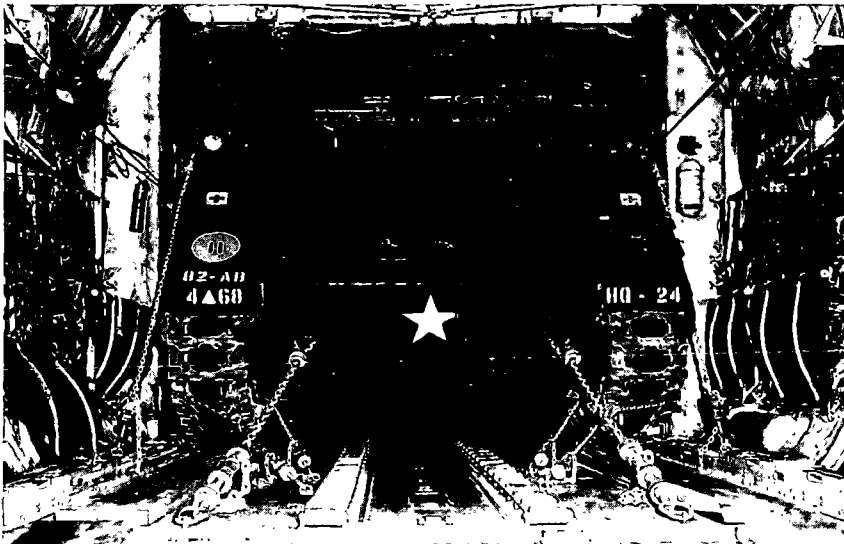
CHAPTER 3

LOAD SHORING

Although modern cargo aircraft can carry very heavy cargo weights, the aircraft are all made of aluminum, a soft metal that can be easily damaged. To protect the soft aluminum aircraft floors, shoring may have to be placed under the cargo. Shoring is lumber, planking, or similar material, larger than the floor contact area of the item of cargo. It is placed on the aircraft cargo floor to distribute the weight evenly over a larger area and prevent damage to the cargo floor. Shoring is so important that it can make the difference between carrying or not carrying a given piece of equipment or load. All shoring used must be provided by the unit being transported.

POSITIONING OF SHORING IN AIRCRAFT

Since aircraft have relatively fragile cargo compartment floors, special care must be taken to make sure that cargo weight is properly distributed over the floor. Certain areas of the cargo compartment floor are stronger than others. For example, the treadway areas of aircraft will support more pounds per square inch (lb/in²) than the other areas of the cargo compartment.



CONTENTS

POSITIONING OF SHORING IN AIRCRAFT
THE NEED FOR SHORING
SIZE AND CONDITION OF SHORING
TRANSPORTING SHORING
TYPES OF SHORING
HOW MUCH SHORING TO USE
FORMULAS
SUMMARY

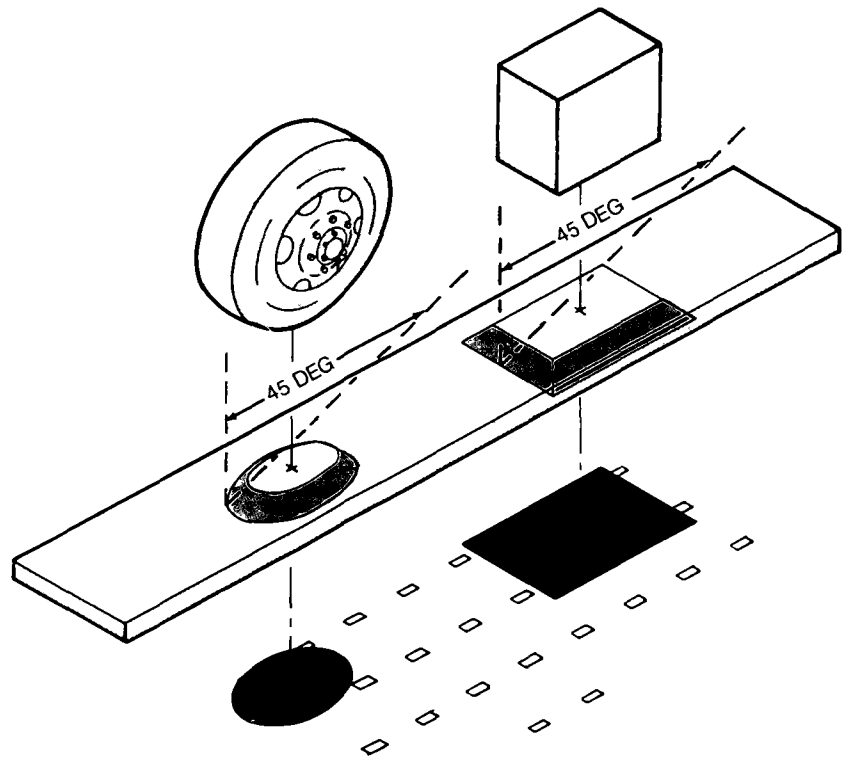
**ARMORED
PERSONNEL CARRIER**

When shoring is positioned on the floor, it should be placed to take advantage of the strongest areas such as the treadways and other floor supporting points. The aircraft loadmaster will supervise the positioning of shoring in the aircraft.

THE NEED FOR SHORING

Although shoring is used to spread out the weight of a load, the weight of that load is not spread over the entire surface of the shoring. Shoring will only increase the area over which a load rests at an angle of 45 degrees from the load to the surface on which the shoring rests.

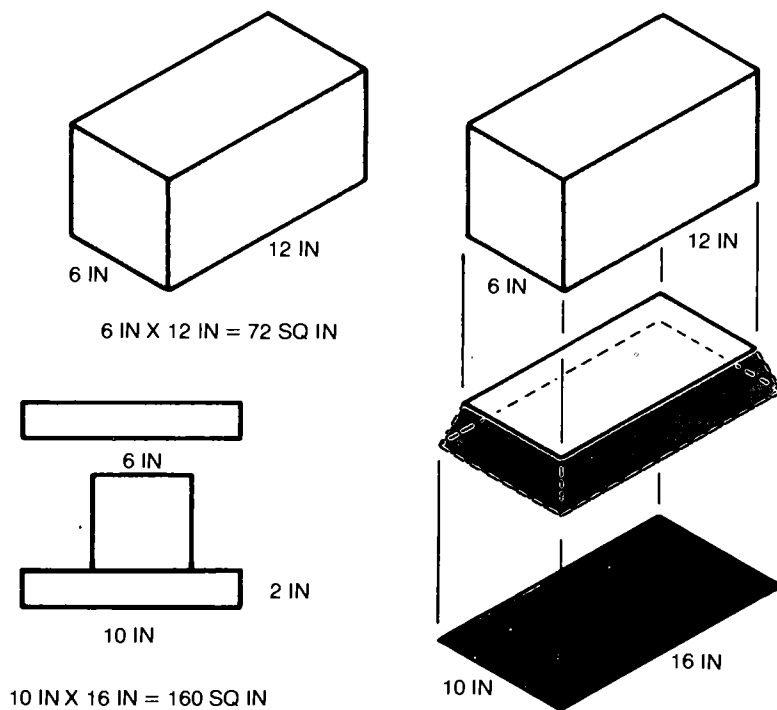
**WEIGHT SPREADING
EFFECT OF SHORING**



Shoring will only increase the area of contact equal to the shoring thickness on all sides of the object resting on it. For example, a 2-inch thickness of shoring will increase the area of contact by 2 inches on all sides of the item resting on it. The spreading effect of simple shoring is the same regardless of the shape of the area of contact.

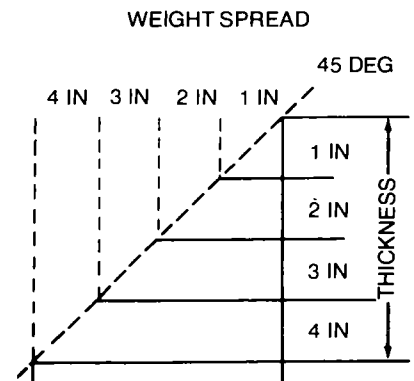
To determine how much shoring to use for a given load, consider the area of contact between the load and the shoring, compared to the area of contact of the shoring with the aircraft cargo floor. In calculating the contact area for rectangular loads, the width of the item is multiplied by its length.

Assume that a plank is 2 inches thick, and a box resting on it is 12 inches long by 6 inches wide. The area of contact between the box and the plank will be 6 x 12 inches or 72 square inches. Extend imaginary planes downward and outward from the edges of the bottom of the box through the plank at 45-degree angles. Where these imaginary planes meet the cargo floor, the area of



contact will be 10 x 16 inches, or 160 square inches. In this case, the area of contact has been increased by 122 percent, or more than doubled. When 2-inch thick shoring is used, the area over which the load is distributed is enlarged by a border 2 inches wide all around the area of contact of the load and the shoring. This border is as wide as the shoring is thick. If the shoring is 1

LOAD SPREADING EFFECT OF SHORING

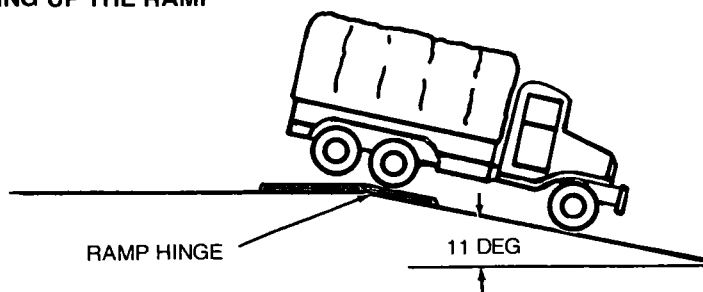


inch thick, the load-bearing border added is 1 inch wide. If the shoring is 3 inches thick, the load bearing border added is 3 inches wide, and so on. Generally, the use of shoring more than 4 inches thick is not practical. The relation between the width of the border and the thickness of the shoring applies to all shoring.

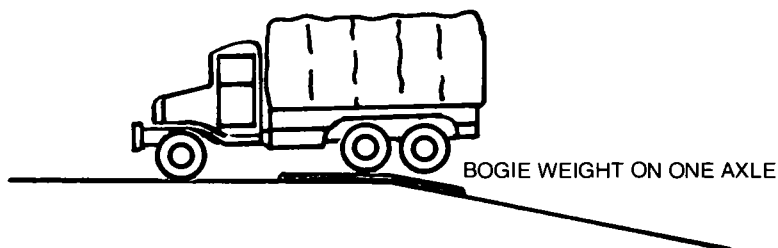
The wheels on some type of vehicles may be difficult to get over the aircraft loading ramp hinge or crest. The crest is the point where the loading ramp attaches to the cargo compartment floor. If the crest angle or angle of incline of the loading ramp is greater than the bogie-action angle of a tandem-axle vehicle, the total bogie wheel load may be transferred onto the wheels of a

**SHORING USED TO
CHANGE THE RAMP
CREST ANGLE**

BACKING UP THE RAMP



BACKING DOWN OR DRIVING FORWARD UP THE RAMP



single axle when the bogie reaches the ramp crest. When this happens, wheel loads are doubled and the floor on either side of the ramp crest may be overloaded unless shoring is used to spread the load over a larger area.

If you think the ramp crest angle will exceed the bogie action angle of a specific vehicle, check the wheel loads to determine if they exceed the maximum weight and require shoring. Shoring must be placed on the treadway area of the aircraft floor for the distance that the excess load is to be moved.

SIZE AND CONDITION OF SHORING

Shoring will probably be needed for each aircraft load you plan. The thickness and width of the shoring to be used is determined by the load configuration and weight. In general, lumber 10 or 12 inches wide and 2 inches thick is most suitable. Lengths of shoring can be cut to meet specific needs. For ease of handling, however, the length of shoring should not exceed 12 feet. Plywood also makes good shoring. One 4-foot by 8-foot sheet of $\frac{3}{4}$ -inch plywood can be cut to provide four 1-foot by 8-foot or two 2-foot by 8-foot pieces of shoring, which are ideal for loading tracked vehicles.

Inspect shoring before use to insure that it is clean, sound, free of nails, and fit for its intended use. Remember, any defect in the lumber will reduce its strength. Split lumber will not transfer the weight of the cargo past the split. Dirty or badly warped lumber may be rejected by the cargomaster, causing a delay in loading the aircraft.

TRANSPORTING SHORING

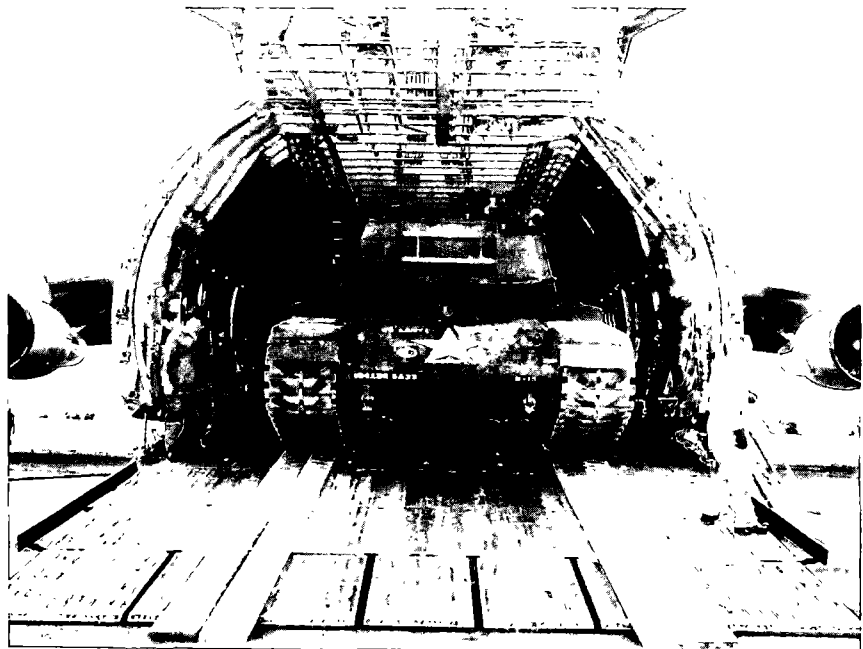
When shoring is required for loading cargo, it will also be needed for unloading. If shoring is not available at destination, then the shoring must be transported with the load. The weight of the shoring must be included with the weight of the cargo to accurately determine the aircraft center of gravity. For tracked vehicles, you can simply load the lumber on top of the vehicle while it is being weighed. The weight of the shoring will not affect the vehicle center of balance enough to matter. For an RT forklift or another piece of equipment that requires sleeper shoring, you may have to weigh the shoring separately and add the weight to the vehicle. For a trailer or another piece of equipment that only requires shoring under the tongue, you do not need to worry about the weight, but you must make sure you always have the shoring available.

TYPES OF SHORING

There are five basic types of shoring used for loading, transporting, and unloading. These types of shoring are named for the way in which they are used to protect an aircraft floor.

- Rolling Shoring
- Parking Shoring
- Bridge Shoring
- Sleeper Shoring
- Approach Shoring

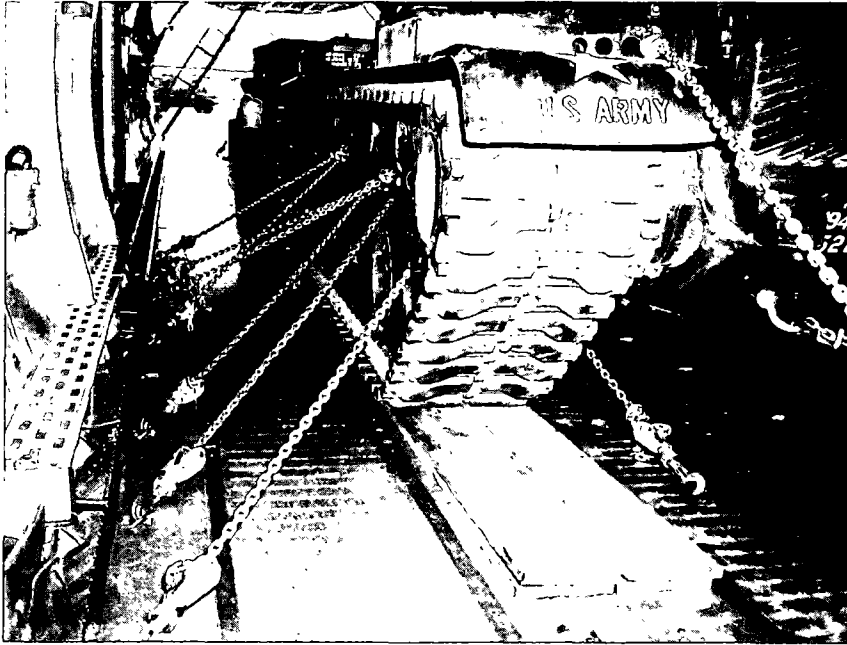
Rolling shoring is used on ramps and floor areas over which a vehicle must roll when being loaded onto, or unloaded from, an aircraft. Most vehicles equipped with pneumatic tires do not exceed floor and ramp limits. Vehicles with tracks, cleats, studs, or other gripping devices or treads where there will be metal-to-metal contact require rolling shoring. Tracks or cleated or lugged wheels damage the cargo floor because the weight of the vehicle is carried on the cleats and lugs and is, therefore, concentrated on a very small surface. Vehicles with cleats and lugs must have planking thick enough for them to sink into, and the load must be spread enough that the limiting weight per square inch on the aircraft cargo floor will not be exceeded.



ROLLING SHORING

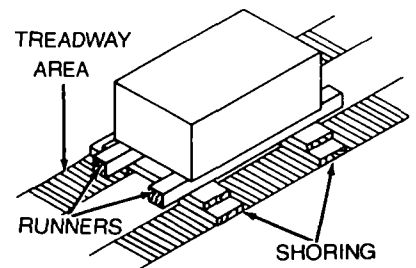
Parking shoring is that shoring required under vehicles aboard the aircraft in flight. A vehicle that requires rolling shoring also

requires parking shoring. Rolling shoring requirements related to tracked, lugged, cleated, and hard-tired vehicles, and to other types of cargo, also apply to parking shoring.



PARKING SHORING

Bridge shoring is used to take advantage of the greater strength of the vehicle treadways of the aircraft cargo floor; it allows heavy cargo to be positioned between the treadways without overloading the center floor area. Shoring is first placed either lengthwise, nose-to-tail, or laterally on the treadways. The positioning of the shoring on the treadways depends on the load to be supported and the strength of the aircraft floor. Planks or beams are positioned on top of the shoring planks and from the bridge. The bridge must be strong enough that any sag under the load is not readily apparent. When beams are used, they should be at least as wide as they are thick.

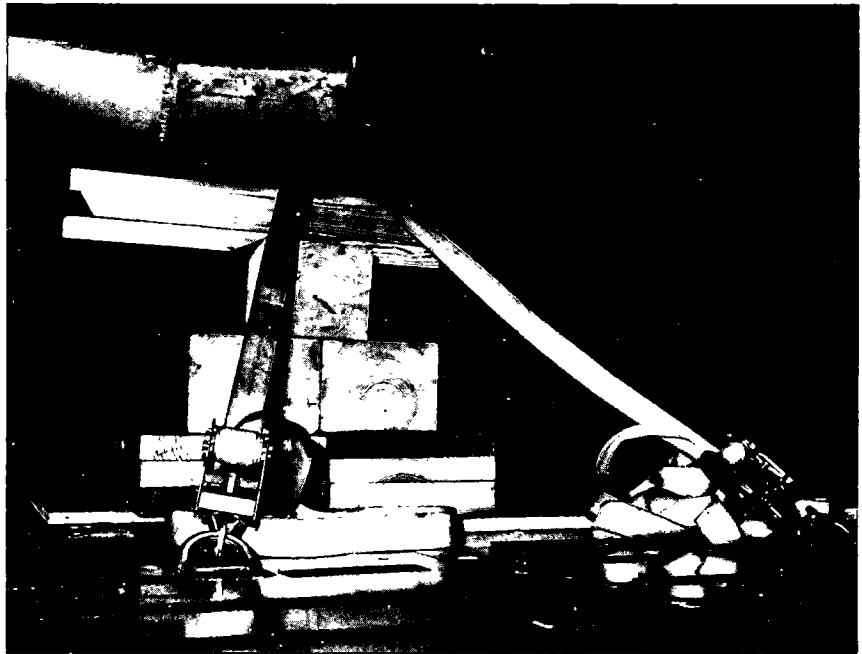


BRIDGE SHORING

Sleeper shoring is required for vehicles weighing over 20,000 pounds, with soft tires. Shoring is used to prevent the vehicle with soft tires from bouncing up and down and possibly pulling tiedown devices out of the floor. A soft tire is defined as a low-pressure, balloon-type, off-the-highway tire with less than 80 lb/in² inflation pressure. The support is accomplished by positioning shoring as "sleepers" between the aircraft floor and the vehicle axles or chassis. The shoring is placed as close to the axle

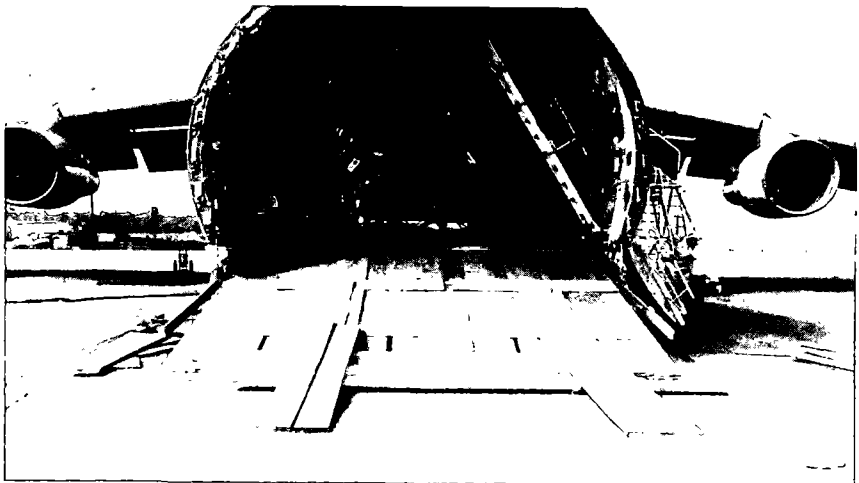
as possible so the vehicle won't bounce on the soft tires. Normally, 2-by-8-inch or 4-by-4-inch lumber is best suited for sleeper shoring. Care must be taken to insure that the pressure on the floor contact area of the load will not exceed the aircraft cargo floor capacity.

SLEEPER SHORING



Approach shoring is used to decrease the steepness of the aircraft ramp to provide more overhead clearance in the aircraft

APPROACH SHORING



cargo compartment or ground clearance at the end of the ramp or ramp extensions. You must usually use approach shoring when loading helicopters due to the critical height restrictions at the ramp crest.

HOW MUCH SHORING TO USE

To find out how much shoring to use, you must be able to find how many pounds per square inch (lb/in²) of pressure the cargo will put on the aircraft floor. All aircraft are built with a pound-per-square-inch limitation, so the purpose of the calculations is to find the **minimum** amount of shoring necessary to do the job. Too much shoring may make the cargo too heavy to fly; too little shoring may allow the aircraft to be damaged by the weight of the cargo.

To find the pressure rating of a piece of cargo, you must use two formulas: one to find how many square inches of the piece of cargo will come in actual contact with the cargo floor (area), and the second to find the actual pressure of the piece of cargo. For example: you have a piece of cargo packed in a wooden crate. The length of the crate is 24 inches, and its width is 24 inches. The crate weighs 1,000 pounds. By multiplying the length by the width, you get the area; in this case, 576 square inches.

To find the lb/in² of that piece of cargo, divide the weight by the area, which gives you 1.8 lb/in².

If you know that the aircraft floor limit is 1.4 lb/in², then you will have to put shoring under the crate to spread the load. A 1-inch piece of shoring will not be enough, so you put a 2-inch board under the cargo. Remember, since shoring is not effective under its entire length, but only at a 45-degree angle from the edge of the piece of cargo, 2-inch shoring will spread the load only 2 inches on each side of the cargo, which results in spreading the load over an area of 28 by 28 inches. This would reduce the lb/in² to 1.3. Therefore, with a 2-inch board measuring 28 by 28 inches under the crate, it is safe to place the crate into the aircraft.

Many military cargo items are packed in boxes that are mounted on skids or on pallets. Although this makes the material easier to handle with a forklift, it will put more strain on the aircraft cargo floor because the skids are smaller than the piece of cargo.

$$L \times W = A$$

$$24 \times 24 = 576 \text{ in}^2$$

$$\frac{W}{A} = \text{lb/in}^2$$

$$\frac{1,000}{576} = 1.8 \text{ lb/in}^2$$

$$28 \times 28 = 784 \text{ lb/in}^2$$

$$\frac{1,000}{784} = 1.27 \text{ or } 1.3 \text{ lb/in}^2$$

L x W x no. of skids = area

$$41 \times 3 \times 2 = 246 \text{ in}^2$$

$$\frac{1,700}{246} = 7.0 \text{ lb/in}^2$$

L x W x no. of skids = area

$$45 \times 7 \times 2 = 630 \text{ in}^2$$

$$\frac{1,700}{630} = 2.69 \text{ or } 2.7 \text{ lb/in}^2$$

To find the area of the skids, you will have to measure the skid, not the cargo item, and multiply by the number of skids.

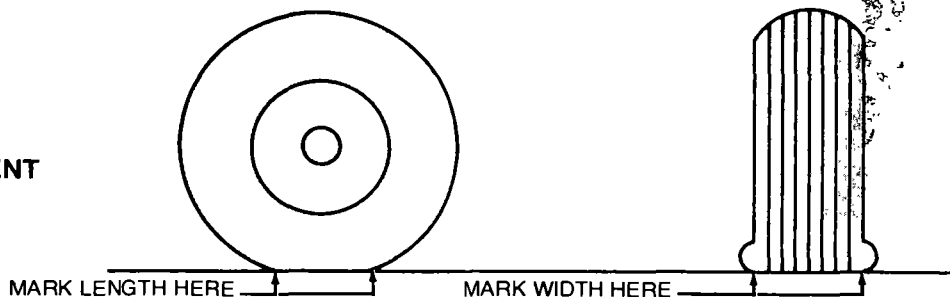
For example, you have a piece of cargo 41 inches long and 24 inches wide weighing 1,700 pounds and mounted on two skids 41 inches long by 3 inches wide. In this case, the area of each skid times two would be used to determine the lb/in² which, for this load, would be 7.0

By placing 2-inch shoring under the skids, you would decrease the lb/in² to 2.7.

NOTE: When "rounding" figures **always** round **pressure** figures **up** to the next higher tenth inch. For example, 2.69 lb/in² would round up to 2.7 lb/in². **Always** round **area** figures **down** to the next lower tenth; e.g., 7.58 will be 7.5 in². This will provide an increased safety factor by making your lb/in² higher than it actually is, and your area smaller than it actually is.

Although many vehicles with pneumatic tires will not need shoring, some very heavy vehicles will need shoring under their tires to spread their weight. To find the area of a vehicle tire pad, you must measure the length and width of the tire pad as it

TIRE PAD MEASUREMENT



L x W x 0.785 = area

$$8 \times 5 \times 0.785 = 3.14 \text{ in}^2$$

$$\frac{2,000}{31.4} = 63.69 \text{ or } 63.7 \text{ lb/in}^2$$

sits on a hard surface. The tire pad as it sits on a hard surface is not square, but slightly rounded, so you have to compensate for this by multiplying the area by 0.785. For example, the load pressure of a tire pad measuring 8 by 5 inches and 2,000 pounds is 637 lb/in².

A piece of 2-inch shoring under the same tire will decrease the load pressure to 23.7 lb/in².

Under normal operational conditions, you will not know the wheel weight of the vehicle, but only the axle weight. Then you must multiply the tire pad area by the number of wheels before

you can find the lb/in². For example, an RT forklift has a front axle weight of 13,000 pounds and the tire pad of each of its two tires is 10 by 12 inches. This results in a load pressure of 69 lb/in².

Frequently the front and rear axle weights will not be the same. The pressure for each axle must then be found. If the rear axle of a vehicle is a tandem bogie axle, you must weigh the front and rear of the bogie and divide by 4 if you are using wheel scales. If you are using a larger scale that weighs the entire bogie axle, remember to divide your final figure by 8; that is, by the number of tires on that axle.

Shoring is always necessary for tracked vehicles and vehicles with steel cleats or tires. It is not usually necessary to do a series of calculations to figure out how much to use. When loading an M113 series vehicle (e.g., M113A1, M126, M577, etc.) rolling and parking shoring of 1 inch by 10 inches, 12 feet long, is sufficient. For loading tanks and other very heavy vehicles, you will have to use double widths of 10- or 12-inch shoring to protect the aircraft cargo floor. The ground pressure exerted by most tracked vehicles is relatively slight, but shoring must be used to protect the aircraft floor from gouging as the vehicles are moved and parked.

$$12 \times 9 \times 0.785 = 84.78 \text{ in}^2$$

$$\frac{2,000}{84.7} = 23.61 \text{ or } 23.7 \text{ lb/in}^2$$

$$L \times W \times 0.785 \times \text{no. wheels} = \text{area}$$

$$10 \times 12 \times 0.785 \times 2 = 188.4 \text{ in}^2$$

$$\frac{13,000}{188.4} = 69.0 \text{ lb/in}^2$$

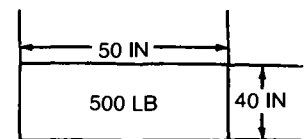
FORMULAS

The basic formulas for computing area and pounds of pressure for various shaped objects are given here for your reference.

RECTANGLE

Weight divided by length times width.

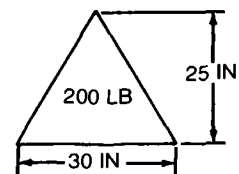
$$\frac{\text{Weight}}{\text{Length} \times \text{Width}} = \text{Pressure} \quad \frac{500}{50 \times 40} = 0.25 \text{ lb/in}^2$$



TRIANGLE

Weight divided by one half the base of triangle times the height.

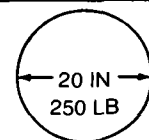
$$\frac{\text{Weight}}{\frac{1}{2} \text{ Base} \times \text{height}} = \text{Pressure} \quad \frac{200}{15 \times 25} = 0.53 \text{ or } 0.6 \text{ lb/in}^2$$

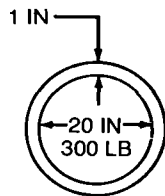


CIRCLE

Weight divided by diameter squared times 0.785.

$$\frac{\text{Weight}}{\text{Diameter}^2 \times 0.785} = \text{Pressure} \quad \frac{250}{20^2 \times 0.785} = 0.79 \text{ or } 0.8 \text{ lb/in}^2$$



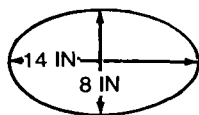


CIRCULAR BARREL WITH RIM

Weight divided by outside diameter squared minus inside diameter squared times 0.785.

$$\frac{\text{Weight}}{\frac{\text{Outside Diameter}^2 - \text{Inside Diameter}^2 \times 0.785}{300}} = \text{Pressure}$$

$$\frac{300}{22^2 - 20^2 \times 0.785} = 4.54 \text{ or } 4.6 \text{ lb/in}^2$$



TWO-WHEELED AXLE
WEIGHT 1,100 LB

TIRE PAD

Weight of axle divided by length times width of tire pad times 0.785 times number of tires on the axle. (Each axle of a vehicle must be computed separately.)

$$\frac{\text{Weight of Axle}}{\frac{\text{Length} \times \text{Width} \times 0.785 \times \text{No. Tires on Axle}}{1,100}} = \text{lb/in}^2$$

$$\frac{1,100}{14 \times 8 \times 0.785 \times 2} = 6.25 \text{ or } 6.3 \text{ lb/in}^2$$

SUMMARY

In this chapter you have seen that each type of aircraft has a maximum floor pressure it can withstand. These limits, usually stated in pounds per square inch, are found in each aircraft dash nine (-9) loading technical order. When the area and weight ratio of an item of cargo exceeds the allowable floor pressure, shoring must be placed under the cargo. Shoring is a length of material, usually lumber, that is larger than the floor contact area of the item of cargo. Its main purpose is to spread the weight over a greater area, reducing the crushing pressure applied against the floor of the aircraft. The width, length, and thickness of the shoring depend on the weight and configuration of the load and the allowable floor load.

Shoring is always required for steel-wheeled vehicles, vehicles with cleats or lugs, trailer tongues, and any metal item that is to be placed on the cargo floor. Lumber 10 to 12 inches wide, 2 inches thick, and up to 12 feet long is a suitable size for most shoring requirements. Proper shoring practices can make the difference between your load's being accepted or rejected for transport.

CHAPTER 4

CARGO RESTRAINT

Cargo in an aircraft must be restrained (tied down) so that it will remain stationary within the cargo compartment when the aircraft is subjected to rough air, vibration, acceleration, deceleration, and rough landings. The greatest force likely to act on the cargo is usually the forward movement encountered when the aircraft slows rapidly upon landing. When the pilot applies the aircraft brakes upon landing, the cargo has a tendency to keep moving at the higher speed. The cargo must also be restrained in proportion to its own weight, so that it will not shift when the aircraft turns, takes off, lands, or encounters other forces while flying. Restraint is done with the use of tiedown devices that are provided aboard the aircraft.

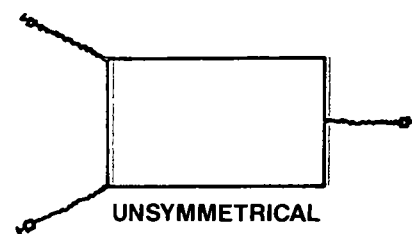
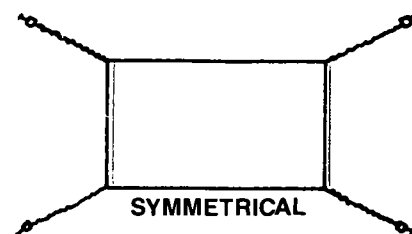
PRINCIPLES OF CARGO RESTRAINT

Cargo loaded in an aircraft must be restrained so that it will not shift during any condition that may be experienced by the aircraft in flight. Basic principles of restraint must be followed when tying down cargo. Although the details will vary for different kinds of cargo, the basic principles of restraint will not change.

- Cargo must be tied down to prevent movement in all directions.
- Tiedown devices must be installed to provide adequate restraint without overstressing the tiedown fitting or damaging the cargo.
- The tiedown must lead from the tiedown fitting on the aircraft floor toward the load being restrained. Do not try to make it go around another object.
- Attach tiedown devices in a symmetrical pattern and in pairs. Unsymmetrical tiedowns permit uneven load distribution, which could result in tiedown failure.
- Tiedown pairs in a given direction must be of the same type and of equal length. (Any material subjected to a tension

CONTENTS

PRINCIPLES OF CARGO RESTRAINT
RESTRAINT CRITERIA
DIRECTION OF RESTRAINT
TYPES OF TIEDOWN DEVICES
APPLICATION OF TIEDOWN DEVICES
DETERMINING REQUIRED NUMBER OF TIEDOWN DEVICES
RESTRAINING CARGO ON PALLETS
SUMMARY



load will stretch to a given percentage of its length. Therefore, the greater the length, the greater the potential amount of stretch. If two tiedowns of the same type and capacity are used to restrain a load in a given direction and one tie is longer than the other, the longer tie, with its greater stretch potential, will permit the shorter tie to assume the majority of any load which may develop. If, as a result, the shorter tie should be overstressed and should fail, the longer tie would be subjected to the full load and it, too, would probably fail.)

- Use nylon devices or padding on cargo that may be damaged by chains.

RESTRAINT CRITERIA

The primary restraint criterion is the minimum amount of restraint needed to keep cargo from moving in a specific direction. A numerical factor (G factor) called *restraint safety factor* or *load factor* has been determined for cargo aircraft; this figure is used to determine the number of tiedown devices to use. Restraint criteria for aircraft cargo are based upon the weight of the cargo and the forces imposed upon it due to changes in motion (changing direction, slowing down, or speeding up). The force increases as the rate of change in motion increases.

Imagine yourself as a passenger in a car that is traveling at 50 mi/h. The driver jams on the brakes and makes a sudden stop. What happens to you when the brakes are applied? The same thing will happen to the cargo in an aircraft. A sudden change in direction or speed of the aircraft tends to move the cargo in the same manner as you were moved by the sudden application of the brakes. The change in motion is called the *outside force*. The amount of outside force to which a unit of cargo may be subjected is called the *load* or “G” factor. When the weight of a unit of cargo is multiplied by the “G” factor, the result is the amount of required restraint for that unit of cargo. This may be stated as:

$$\text{Weight} \times \text{“G” Factor} = \text{Required Restraint}$$

Example: A unit of cargo is to be restrained from moving forward and the forward “G” factor for the aircraft is 3. If the cargo weighed 5,000 pounds, the total load to be restrained would be determined by use of the formula as follows: Cargo

weight (5,000 pounds) $\times$ "G" Factor (3) = 15,000 pounds, or the weight to be restrained against forward movement.

DIRECTION OF RESTRAINT

The restraint criteria applied to the cargo to prevent its movement are identified by the direction in which the cargo would move if it were not restrained. Forward restraint keeps cargo from moving forward in the aircraft. Aft restraint keeps it from moving backward. Lateral restraint keeps it from moving to either side. Vertical restraint keeps it from moving upward off the aircraft floor. Downward restraint is provided by the aircraft floor.

TYPES OF TIEDOWN DEVICES

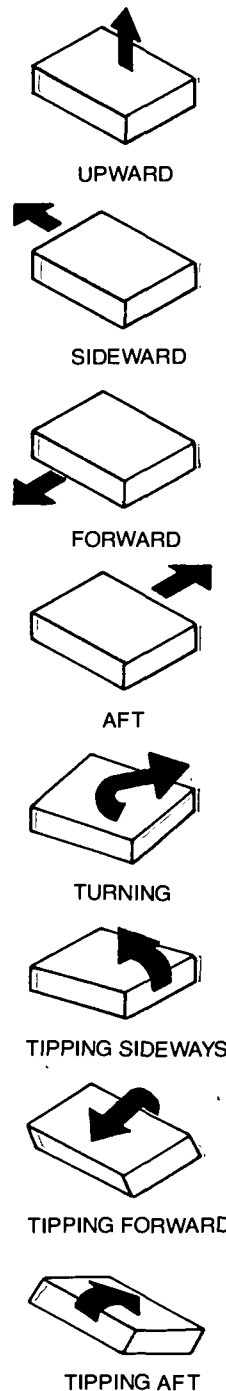
There are three basic tiedown devices used to secure cargo in the aircraft. They are:

- The MB-1 Tiedown Device, which has a 10,000-pound capacity
- The MB-2 Tiedown Device, which has a 25,000-pound capacity
- The CGU-1/B Tiedown Device, which has a 5,000-pound capacity.

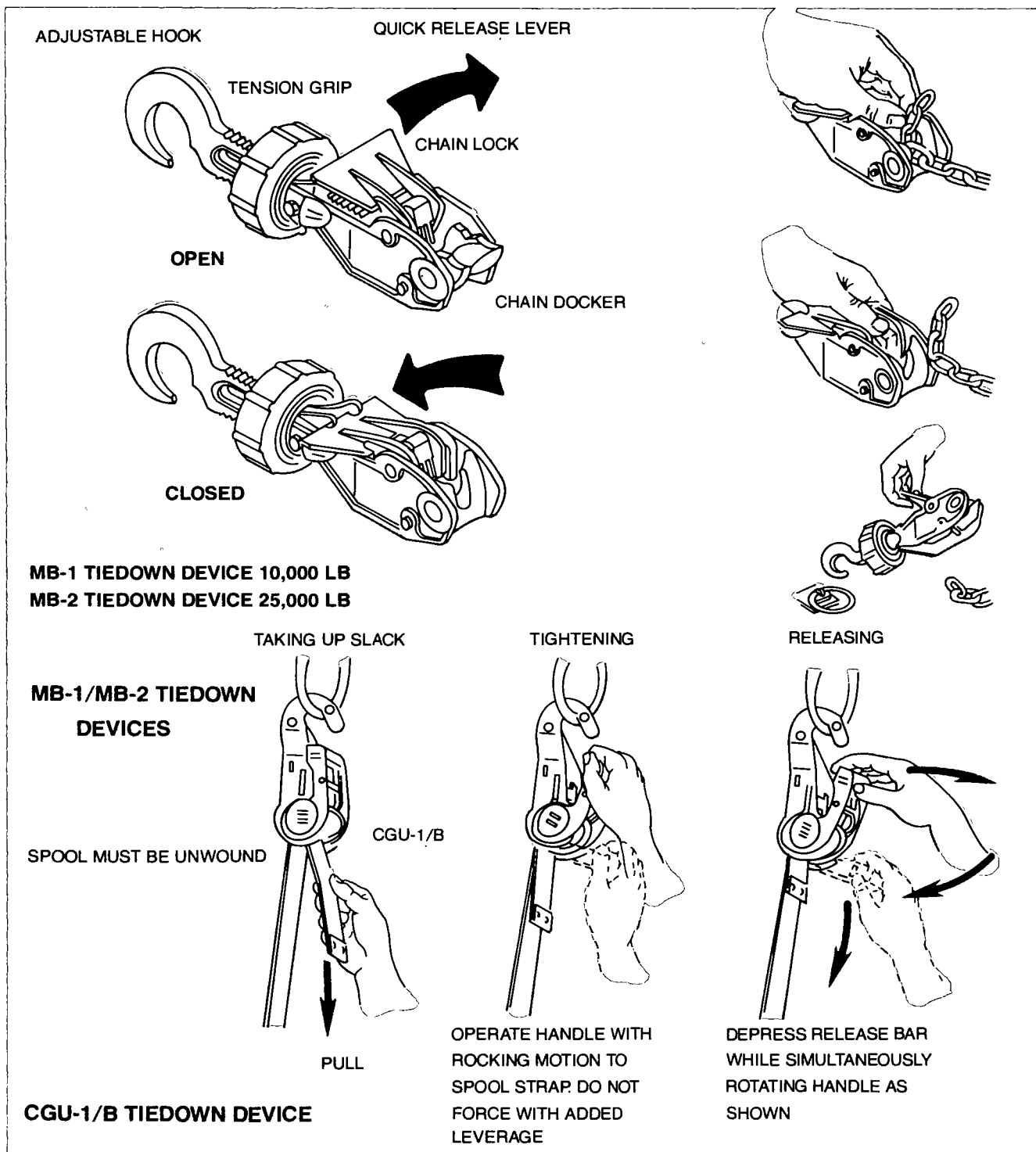
The MB-1 and MB-2 devices, shown on page 4-4, are similar to each other in looks, in the way they operate, and in the manner in which they are to be used. The only significant differences between these devices are in their load capacities and size.

These devices are operated in the same manner: each has an L-shaped hook end that is passed over and around part of the load; the hook is then engaged with a link of the chain. The MB-2 has a heavier chain and stronger component parts than the MB-1. The chain and component parts of the MB-2 are heavy enough to allow the device to have a rated capacity of 25,000 pounds, while the MB-1 has a rated capacity of only 10,000 pounds.

The CGU-1/B tiedown device, also illustrated on page 4-4, is a 20-foot-long nylon web strap which has two metal hooks attached. One hook is stationary at one end of the strap, while the other hook has a ratchet device attached and can be moved over the length of the strap. The ratchet is used to tighten the device when it is being used.



POSSIBLE CARGO MOVEMENT



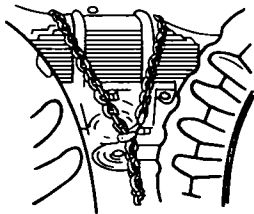
APPLICATION OF TIEDOWN DEVICES

RULES FOR TIEDOWN DEVICE APPLICATION

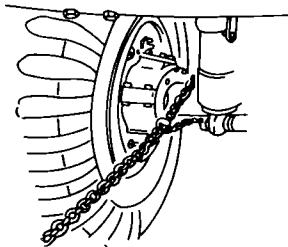
Similar methods are used to restrain all types of cargo. The details of restraining each cargo item vary with its bulk, weight, configuration, location in the aircraft, and whether it is equipped with tiedown provisions. These variations make the tiedown of each piece of cargo a separate problem. Vehicles airlifted through turbulence and other violent motions are subjected to extreme gravitational forces that may allow pneumatic tires to compress and thus slacken tension on tiedown chains. When the motion stops suddenly and the aircraft quickly climbs, the chain will snap taut and impose abnormal loads on aircraft tiedown fittings, tiedown devices, and cargo tiedown fittings. This same reaction may be experienced with vehicle springs flexing under the same conditions.

Special-purpose vehicles, such as RT forklifts, equipped with large soft tires are very likely to encounter these stress conditions in the aircraft. Some vehicles are constructed so that each major component part must be tied down. An example is the truck-mounted crane. The crane is mounted on the truck chassis by a large-diameter kingpin. There are no provisions to prevent the kingpin from being disengaged because of vertical acceleration, so both the truck chassis and the crane must be tied down. The basic rules for applying tiedown devices are:

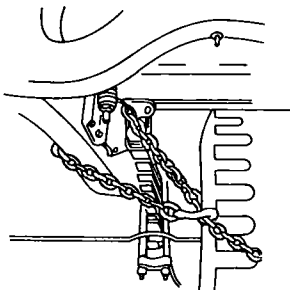
- Use standard tiedown devices that are provided aboard the aircraft.
- Know the capabilities of each tiedown device used.
- Use an even number of chains, and attach them symmetrically in pairs.
- Know the restraint criteria in each direction (forward, aft, lateral, and vertical), then compute the restraint required.
- When attaching tiedown devices to cargo and tiedown fittings, maintain equal tensions throughout the tiedown arrangement.
- Whenever possible, install tiedown devices at an angle of 30 degrees from the cargo floor and 30 degrees from the longitudinal axis.



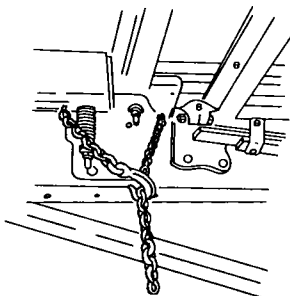
**AROUND EQUALIZER
TRUNNION BAR AND
OVER SPRING**



AROUND AXLE



AROUND FRAME



**OVER FRAME AND
UNDER CROSS MEMBER**

VEHICLE TIEDOWNS

- All aircraft floor tiedown fittings are not the same capacity. Avoid placing a 10,000-pound capacity tiedown device on a 5,000-pound capacity tiedown fitting; it will then provide only 5,000 pounds of restraint.
- Turn the rings in the floor tiedown fittings so that the tension is applied to the top of the ring rather than to the side of the ring.
- When attaching chains to vehicles, consider the capacity of the tiedown device used and the strength of the attaching points. Do not place chains against brake lines, hydraulic lines, fuel lines, tires, or electrical wiring. Attach devices to strong structural points that are available, such as tow hooks, bumper supports, axles, or frame members. Do not attach tiedowns to steering mechanism, tie rods, drive shafts, grills, or fender and body braces.
- Do not attach more than 50 percent of required tiedown devices to vehicle axles.
- When attaching chains so that one crosses over another, make sure that they are pulling in a straight line and not against one another.
- When forming chain loops around axles and bumpers, do not depend on friction or tension to prevent the chain from sliding laterally. Place the chain loop against some solid part such as a differential housing or bumper bracket.
- When using CGU-1/B tiedown devices to tie down cargo with sharp edges, place padding between the device and the cargo in such a way that the padding cannot slip out of place. This precaution will prevent the cargo from cutting the strap while the aircraft is in flight.
- Attach the tiedown devices to the aircraft floor, and the chain to the cargo item.

ANGLE OF TIE

Tiedowns attached to a load usually form three angles that can be measured: a floor angle, a longitudinal plan angle, and a lateral plan angle. The floor angle (sometimes called the vertical

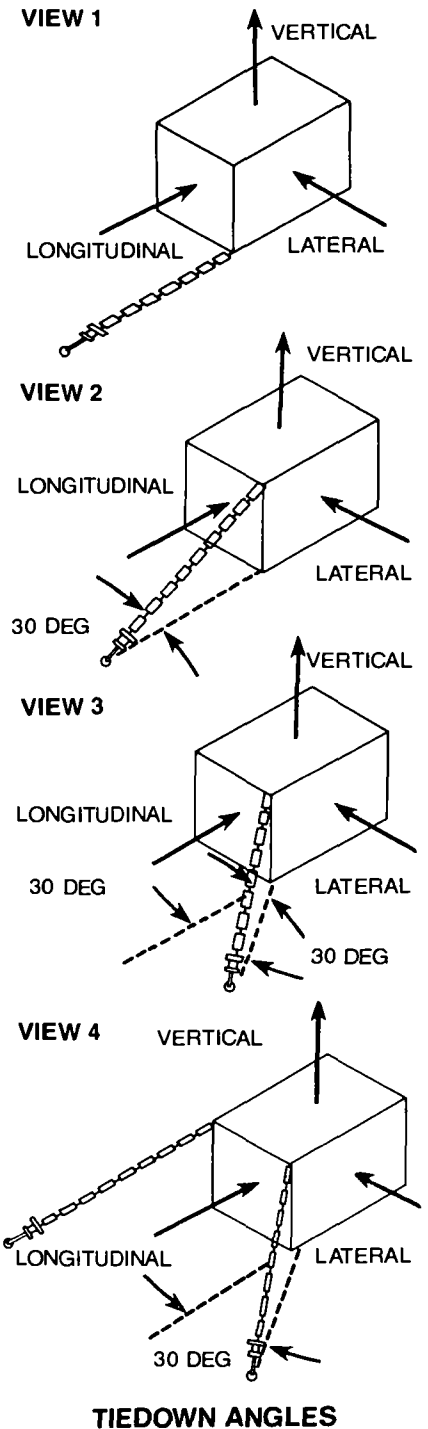
angle) is the BAC in view 2 of the figure shown here. The longitudinal angle (ACD in view 3) is the angle between the chain and a line which runs fore and aft in the cargo compartment through the attachment point. The lateral plan angle (ACE in view 3) is the angle between the chain and a line which runs across the cargo compartment through the attachment point. The tiedown in view 2 is applied at a 30-degree angle to the cargo floor.

In view 3, the tiedown has been moved to a 30-degree longitudinal angle with no change in the floor angle. The tiedown now has a 30-degree floor and a 30-degree plan angle. This tiedown will provide restraint in three directions as indicated by the longitudinal, lateral, and vertical arrows. This 30-degree-30-degree angle is the best combination for the application of tiedown devices. This combination of angles cannot always be achieved because of the configuration of cargo items, location of tiedown fittings, and other cargo items; however, attempt to apply tiedowns as close as practical to the 30-degree-30-degree angle.

TIEDOWN DEVICE STRENGTH

Every tiedown device is rated to withstand a given force. The tiedown devices will restrain up to their rated capacity only when applied so that the force exerted is parallel to, or straight-onto, the device, as shown in view 1. When the tiedown device is applied like this, all of its rated capacity is available to prevent the cargo from moving in the direction of the longitudinal arrow in view 1.

Because it is seldom practical to attach a tiedown device as shown in view 1, it is necessary to attach the device to the aircraft cargo floor, as in view 2. When a tiedown device is attached at an angle, its strength is reduced. The greater the angle, the greater the reduction. For example, the tiedown device shown on page 4-4 is an MB-1, rated at a maximum capacity of 10,000 pounds. As it is applied in view 1, it provides 100 percent of its capacity for restraint in the direction of the longitudinal arrow and very little lateral or vertical restraint. In view 2, the tiedown device is attached to the top corner of the cargo item, resulting in a 30-degree floor angle and a zero-degree plan angle. In this position, the tiedown device will hold 86 percent (8,600 pounds) of its rated capacity against longitudinal forces, 50 percent (5,000



pounds) against vertical (up) forces, and 7.5 percent (750 pounds) against lateral forces. In view 3, the tiedown device is attached so that there is a 30-degree floor angle and a 30-degree plan angle. In this position, the tiedown device will hold 74.9 percent (7,490 pounds) of its rated capacity against longitudinal forces, 50 percent (5,000 pounds) against vertical (up) forces, and 43.3 percent (4,330 pounds) against lateral forces.

NOTE: For ease of illustration, only one tiedown device has been shown in views 1, 2, and 3. These tiedown devices **must** be attached as shown in view 4, in pairs with each device having the same floor and plan angles. Attaching a pair of tiedown devices to the opposite ends of the cargo item in view 4 would provide restraint against movement in all directions.

The percent of angle of tiedown can be determined by using the percentage restraint chart. Floor angle degrees are in the top horizontal row and plan angle degrees are in the left vertical row. To find the percent of effectiveness of a 30-30-degree angle, first read the floor angle across the top of the chart to 30 degrees. The figure directly below the floor angle degree is the amount of vertical (up) restraint in percentage of rated strength for this application. Next read the plan angle down the left side of the chart to 30 degrees. Next to the plan angle are two words; LONG (longitudinal) and LAT (lateral). These represent the direction in which the tiedown will be effective. Now read across the chart until the 30-degree plan angle line intersects the 30-degree floor angle column.

The numbers at this intersection represent the restraint that would be provided by a tiedown device applied at a 30-30-degree angle. These numbers express a percentage of the maximum rated strength of a tiedown device. A device rated at 10,000 pounds would provide 7,490 pounds of longitudinal and 4,330 pounds of lateral restraint and 5,000 pounds of vertical restraint. If the same tiedown device is applied at a 45-degree floor and 45-degree plan angle, it would provide 4,990 pounds of longitudinal restraint, 4,990 pounds of lateral restraint, and 7,070 pounds of vertical restraint.

PERCENTAGE RESTRAINT CHART

NOTE: Angles across the top are those formed between the tie-down device and the cabin floor.
 2. Angles down the side are those formed between the tie-down device and the longitudinal axis of the aircraft.
 * Vertical restraint is related only to the angle between the tie-down device and the cabin floor. The lateral angle has no bearing on it.
 ** The "best compromise" position.

FLOOR ANGLE - DEGREES

PLAN ANGLE - DEGREES		FLOOR ANGLE - DEGREES																
		5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°
5°	VERTICAL *	8.7	17.4	25.9	34.2	42.3	50.0	57.4	64.3	70.7	76.6	81.9	86.6	90.6	93.9	96.6	98.5	99.6
	LONG	99.2	98.1	96.2	93.6	90.2	86.3	81.6	76.3	70.4	64.0	57.2	49.8	42.1	34.1	25.8	17.3	8.7
	LAT	8.7	8.6	8.4	8.2	7.9	7.5	7.1	6.7	6.2	5.6	4.9	4.4	3.7	2.9	2.3	1.5	0.8
10°	LONG.	98.1	97.0	95.2	92.6	89.2	85.3	80.7	75.5	69.6	63.3	56.5	49.3	41.7	33.7	25.5	17.1	8.6
	LAT	17.3	17.1	16.8	16.6	15.8	15.1	14.3	13.3	12.3	11.2	9.9	8.7	7.4	5.9	4.5	3.0	1.5
15°	LONG.	96.2	95.2	93.3	90.8	87.5	83.7	79.1	73.9	68.3	62.1	55.4	48.3	40.9	33.0	25.0	16.8	8.4
	LAT	25.8	25.5	25.0	24.3	23.5	22.4	21.2	19.8	18.3	16.7	14.9	12.9	10.9	8.9	6.7	4.5	2.3
20°	LONG.	93.6	92.6	90.8	88.4	85.2	81.4	76.9	72.0	66.5	60.4	53.9	47.0	39.8	32.1	24.3	16.6	8.2
	LAT	34.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.9	19.6	17.1	14.5	11.7	8.9	5.9	2.9
25°	LONG.	90.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.8	7.9
	LAT	42.1	41.7	40.9	39.8	38.3	36.6	34.6	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4	3.7
30°	LONG.	86.3	85.3	83.7	81.4	78.5	**74.9	70.9	66.3	61.2	55.7	49.7	43.3	36.6	29.6	22.4	15.1	7.5
	LAT	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.9	8.7	4.4
35°	LONG.	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3	7.1
	LAT	57.2	56.5	55.4	53.9	52.0	49.7	47.0	43.9	40.6	36.9	32.9	28.7	24.3	19.6	14.9	9.9	4.9
40°	LONG.	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.9	38.3	32.4	26.2	19.8	13.3	6.7
	LAT	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2	5.6
45°	LONG.	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.9	45.5	40.6	35.4	29.9	24.2	18.3	12.3	6.2
	LAT	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.9	45.5	40.6	35.4	29.9	24.2	18.3	12.3	6.2
50°	LONG.	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2	5.6
	LAT	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.9	38.3	32.4	26.2	19.8	13.3	6.7
55°	LONG.	57.2	56.5	55.4	53.9	52.0	49.7	47.0	43.9	40.6	36.9	32.9	28.7	24.3	19.6	14.9	9.9	4.9
	LAT	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3	7.1
60°	LONG.	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.9	8.7	4.4
	LAT	86.3	85.3	83.7	81.4	78.5	74.9	70.9	66.3	61.2	55.7	49.7	43.3	36.6	29.6	22.4	15.1	7.5
65°	LONG.	42.1	41.7	40.9	39.8	38.3	36.6	34.6	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4	3.7
	LAT	90.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.8	7.9
70°	LONG.	34.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.9	19.6	17.1	14.5	11.7	8.9	5.9	2.9
	LAT	93.6			88.4	85.2	81.4	76.9	72.0	66.5			47.0	39.8	32.1	24.3	16.6	8.2
	LONG.	25.8							21.2	19.8					19.6	17.1	14.5	11.7

PERCENTAGE RESTRAINT CHART

DETERMINING REQUIRED NUMBER OF TIEDOWN DEVICES

There are three ways to determine the number of tiedown devices needed to secure a load in an aircraft:

- The percent of angle of tie
- The restraint data chart
- The length of the tiedown lines.

The percent of angle of tie is the most precise method to find the exact restraint needed. It involves the use of several formulas that require you to know the exact angle of tie before you load the aircraft. The restraint data chart is a quicker method for advance determination of the number of tiedown devices required. It is not as precise as the percent of angle of tie, and is good only for longitudinal restraint.

The length of the tiedown lines can be used to find if enough restraint has been applied to a piece of cargo after it has been loaded into the aircraft. It cannot be used for advance planning.

THE PERCENT OF ANGLE OF TIE

To determine the number of tiedown devices required to properly secure any given item of cargo, you must know how each of the following influences cargo tiedown:

- Weight of cargo
- Restraint required for each direction ("G" force)
- Floor and plan angles of devices when attached
- Rated strength of tiedown devices to be used
- Strength of tiedown fittings on aircraft floor and cargo item.

The first two factors, weight of the cargo and the restraint required, both must be used to find the force that must be restrained. Written in formula form, it would look like:

$$G \times W = F$$

Where:

Restraint needed = G

Weight of the cargo = W

Force to be restrained = F.

The effective holding strength of the tiedown device can be found by multiplying the rated strength of the device by the percent of angles at which it is attached. Written as a formula, it looks like:

$$R \times P = S$$

Where:

Rated strength = R

Percent angle of tiedown = P

Effective strength of each device = S.

To find how many devices to use for each piece of cargo, you combine the results of the first two formulas:

$$\frac{F}{S} = N$$

Where:

Force to be restrained = F

Effective strength of each device = S

Number of devices required = N.

These three formulas will allow you to find how many of each type of tiedown device you should use for each piece of cargo. Remember not to mix the types of devices. If the formulas tell you to use MB-2 devices, do not substitute a lower rated device, or you will not have sufficient restraint.

Remember also that the tiedown devices are to be used in pairs. If your answer does not come out with an exact even number, **always round up to the next highest even number when using chains.** For example, if your figures came out to 2.2 devices you must apply 4. The nylon strap CGU-1/B device does not have to be applied in pairs.

Assume that a cargo item weighing 8,000 pounds is to be restrained to withstand a 3G forward force using MB-1 tiedown devices attached on a 30-degree floor and plan angle. Attached at these angles, the effective holding strength of the MB-1 is 74.9 percent of its rated strength of 10,000 pounds. The formula for determining the required number of devices is:

$$\frac{\text{Wt of cargo} \times \text{Restraint required}}{\text{Strength of device} \times \% \text{ of angle of tiedown}} = \frac{\text{Force to be restrained}}{\text{Effective holding strength of device}}$$

= Total number of devices required, or

$$\frac{G \times W}{R \times P} = \frac{F}{S} = N$$

Substituting numbers, the calculation is:

$$\frac{8,000 \text{ lb} \times 3G}{10,000 \text{ lb} \times 74.9\%} = \frac{24,000}{7,490} = 3.2 \text{ or } 4 \text{ devices needed}$$

The product of this formula gives you only the number of devices required for one direction of restraint. You must use the same process for aft, lateral, and vertical restraint as well. The total amount of calculation may be made easier by displaying all the calculations in table form.

1 Direction of Restraint	2 Restraint Factor	×	3 Cargo Weight	=	4 Force to be Restrained	÷	5 Effective Strength of Device	=	6 Devices Needed	7 Devices Used	8 Restraint Achieved
Fwd	3.0*		35,000		105,000		12,500		10	10	125,000
Aft	1.5		35,000		52,500		12,500		6	6	75,000
Lat	1.5		35,000		52,500		12,500		6	8	100,000
Vert	2.0		35,000		70,000		12,500		6	16	200,000

***NOTE:** If passengers are seated ahead of the cargo, the restraint factor must be 8.0g, except for tactical and contingency movements.

To use the chart, follow the order of calculations as they are listed along the top. Blocks 1 and 2 are always the same. The restraint factors for Air Force aircraft have been determined through scientific analysis, and cannot be changed by the unit. The information in the rest of the blocks must be supplied by the unit.

Block 3, Cargo Weight. This is the total weight of the vehicle or cargo, including any cargo in the vehicles, vehicle fuel, shoring, and any other additions. Do not include the weight of the driver or crew of any vehicle.

Block 4, Force to be Restrained. Multiply block 2 by block 3.

Block 5, Effective Strength of Device. Find this figure by using the chart on page 4-9. Determine the angle of tie you want to use, read right for plan angle and down for floor angle, and find the percent of effectiveness for the device at this angle. Multiply the percent of effectiveness by the rated strength to get the effective strength of the device. Enter the resulting figure in block 5.

Block 6, Devices Needed. Divide block 5 into block 4 and enter the result here. If the product of your division is a fraction, always round up to the next highest even number. (This number is always even, because the tiedown devices are used in pairs.)

Block 7, Devices Used. This figure could be different from the figure arrived at in block 6. When tiedown devices are applied at an angle, they will provide restraint in more than one direction. The same chains used for fore and aft restraint will also provide vertical and lateral restraint. Only if the fore and aft restraint is not sufficient for vertical and lateral restraint will more devices have to be added.

Block 8, Restraint Achieved. Multiply block 7 by block 5. This is a cross-check to insure that enough restraint is being used. If the figure in block 8 is **lower** than that in block 4, more devices must be added.

The example shown in the preceding table is calculations for the number of MB-2 devices necessary to restrain a 35,000-pound vehicle in a C-5A. The angle of tie will be 45-45 degrees.

To arrive at the effective strength of the device (block 5), find the 45-degree plan angle from the chart on page 4-9. Observe that the percent of effectiveness for a device at 45 degrees is nearly 50 percent. Multiply this by 25,000 to get 12,500. Enter this figure in block 5. Perform this calculation 3 more times to get the figure for each direction of restraint. The fore and aft restraint results in block 7 are the results of dividing block 5 into block 4 and carrying the figure out to the next highest even number. The lateral restraint is determined by dividing in half (for each side) the total of the fore and aft devices used.

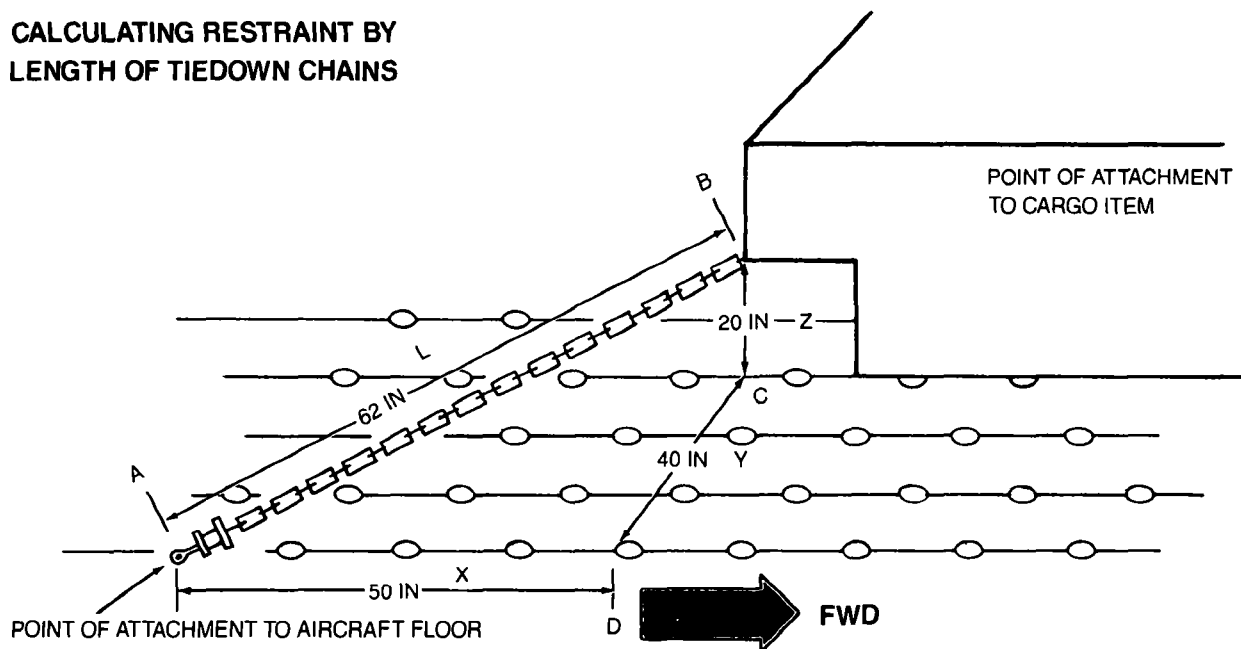
In the example, a total of 16 devices are used for fore and aft restraint; 8 of these devices are applied to each side of the truck. Every device applied will add to the vertical restraint, so all 16 devices are counted in block 7.

THE LENGTH OF THE TIEDOWN LINES

It is not always possible to apply tiedown devices at a known or desired angle because of cargo configuration, or interference by other cargo. After tiedown devices have been applied to a cargo item, their effective restraining strength can be found by measuring the lengths of the chains.

Assume the use of a 10,000-pound capacity MB-1 tiedown device applied to the cargo item shown here.

CALCULATING RESTRAINT BY LENGTH OF TIEDOWN CHAINS



L = Length of line AB

X = Length of line AD

Y = Length of line CD

Z = Length of line BC

When measured, these dimensions are found to be:

L = 62.2 inches

X = 50 inches

Y = 40 inches

Z = 20 inches

Then: $\frac{X}{L} \times 10,000 = \text{Longitudinal restraint}$

$\frac{Y}{L} \times 10,000 = \text{Lateral restraint}$

$\frac{Z}{L} \times 10,000 = \text{Vertical restraint}$

It can now be calculated that:

$\frac{50}{62.2} \times 10,000 = 8039 \text{ pounds longitudinal restraint}$

$\frac{40}{62.2} \times 10,000 = 6431 \text{ pounds lateral restraint}$

$\frac{20}{62.2} \times 10,000 = 3215 \text{ pounds vertical restraint}$

Using this method, load planners can calculate the restraint for each device. If the calculated restraint for any of the forces is less than required, add more devices.

RESTRAINING CARGO ON PALLETS

The Air Force 463-L cargo handling system is designed to increase loading and unloading efficiency and to reduce operating costs. Small items of cargo are difficult to properly restrain. Cardboard CONEX inserts or standard wood pallets may be used to consolidate small items into a larger unit. CONEX inserts containing cargo, and wood pallets with cargo, will then be placed on Air Force 463-L cargo pallets and secured with Air Force cargo restraining nets.

The three nets of the 463-L pallet will restrain up to 10,000 pounds of general cargo on any single pallet without having to use any other tiedown devices. The 463-L pallet may be used as a mobility platform for other than general cargo weighing more than 10,000 pounds. Palletized loads over 10,000 pounds cannot be restrained with nets, and must be secured with chains and devices to the aircraft floor, the pallet rings, or restraint rail tiedown rings. Close attention must be paid to aircraft load restrictions.

SUMMARY

Aircraft cargo must be properly secured to prevent its movement in flight. If cargo is not properly secured, it will shift when the aircraft changes speed or rapidly changes direction. This could injure personnel, damage the aircraft, and damage the cargo. The cargo must be restrained so that it will not shift as a result of any condition that might be experienced by the aircraft in flight or during takeoff and landing. Proper tiedown of cargo is accomplished by following the fundamental principles of restraint. Restraint criteria will assist in determining the required amount of restraint for each cargo item.

There are three basic tiedown devices provided aboard the aircraft for securing cargo. The MB-1 device has a maximum rated capacity of 10,000 pounds; the MB-2 device is rated at 25,000 pounds; and the CGU-1/B is rated at 5,000 pounds. Tiedowns in a given direction (applied in pairs) will be of the same type and of equal length. A single tiedown is only as strong as its weakest part: a 10,000-pound-capacity device, attached to a 5,000-pound-capacity tiedown ring on the aircraft floor, cannot provide more than 5,000 pounds of restraint.

There are 15 basic rules for applying tiedown devices listed in this chapter. Violation of any of these rules could have adverse results. It is usually necessary to apply tiedown devices in a manner that results in the formation of three angles between the device and the aircraft. These angles are called the floor angle, the longitudinal plan angle, and the lateral plan angle. These angles have a direct influence on the effective strength of the tiedown devices. The greater the angle, the lower the effective strength. Determination of the number of devices required to restrain an item of cargo is based on the weight of the item, the restraint required for each direction, the floor and plan angles of devices when attached, the rated strength of devices to be used, and the strength of tiedown fittings on the aircraft floor and cargo item.

Small cargo items should be consolidated for increased efficiency of handling and securing aboard the aircraft. The 463-L pallet system has the capacity to secure up to 10,000 pounds of cargo, and is especially useful for the consolidation of small cargo items.

CHAPTER 5

BASICS OF AIRCRAFT LOAD PLANNING

The previous chapters have outlined aircraft characteristics and shown how to shore and restrain cargo. This chapter will show you how to carefully plan an air movement prior to any loading of an aircraft to insure that the aircraft is used efficiently.

Load planning will show you whether a given load can be carried in an aircraft, and help you decide exactly where each item of cargo should be placed inside the aircraft. Load planning will tell you how to determine the balance points of the load (vehicles and cargo) and the weight and balance of the aircraft.

Load planning will help you determine what preparations you must make in getting the equipment ready for flight, and what loading aids may be needed.

LOAD PLANNING CONSIDERATIONS

There are some basic considerations which affect the aircraft and aircraft stability. Before any load planning can begin you must know the following.

- The center of gravity (cg) of the aircraft.
- Placement of the cargo in the aircraft so that the weight and balance check will not require rearranging of the cargo. Usually the heaviest items of cargo are placed in the aircraft cg area, with the lighter items forward and aft.
- Location of the emergency exits. Cargo should not block any passenger or emergency door.
- Location of the safety aisle. Cargo should never obstruct the required safety aisle that permits the crew to move freely from the front to the rear of the aircraft.
- Location of aircraft emergency equipment. Cargo should never be placed in locations where it could interfere with the aircraft's emergency equipment.

CONTENTS

LOAD PLANNING
CONSIDERATIONS

TYPES OF LOADS

THE 463-L CARGO SYSTEM

WEIGHT AND BALANCE

PLACEMENT OF AIRCRAFT
LOADS

LOADING PROCEDURES

SUMMARY

- Cargo loading order. The cargo scheduled to be offloaded first is usually the last cargo loaded.
- Requirement for hazardous cargo marking and documentation.

Other load planning considerations relate directly to the deploying unit, the unit's mission, and the expected scheme of operation upon arrival at destination. Detailed planning considerations and responsibilities are set forth in FM 55-12.

TYPES OF LOADS

Aircraft loading is generally categorized into two types:

- Concentrated Loading
- Palletized Loading

Concentrated Loading Concentrated loads are very large or heavy items, such as vehicles, tanks, or construction equipment. You must compute the precise station location upon which the cargo is to be placed inside the aircraft. In order to properly place the cargo on a specified station, the cargo item must be marked with the correct center of balance. Since station computations enter into this method of loading, it is also referred to as *station loading*.

Palletized Loading The entire aircraft load generally consists of preloaded 463-L pallets, properly secured and ready for flight. The center of each pallet is considered to be its center of balance unless the pallet is marked otherwise. The pallets are positioned and secured in the aircraft by means of the 463-L restraint rail system.

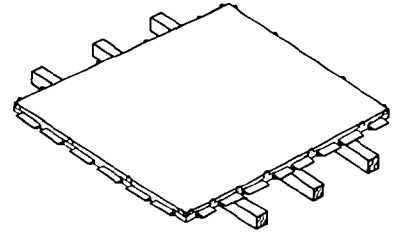
THE 463-L CARGO SYSTEM

Although air transportation of cargo has been in use almost since the first use of airplanes, there has not been an easy way to get cargo into and out of the aircraft. The 463-L cargo system was designed to reduce the time required to load and unload an aircraft.

The 463-L system consists of three basic elements. The one most familiar to Army users of Air Force aircraft is the standard cargo pallet, called the 463-L pallet. This pallet is a 2½-inch-thick aluminum pallet with a balsa wood core. It has 9 slots along

the side that are designed to fit into a locking device on the aircraft. The pallet is 88 inches by 108 inches; it can be used to hold up to 10,000 pounds of cargo stacked as high as 96 inches. It is a very strong but lightweight pallet, but it can be damaged by misuse. The balsa core will absorb water if the pallet is left in standing water, but it can withstand rain without difficulty. The pallet will also bend easily if not stored correctly, rendering it useless for the movement of cargo. Storage should be only with three pieces of dunnage under the pallet, and stacked no more than 10 high.

The second element is a truck or K-loader, with a roller bed and locking devices designed to move the loaded pallet from a staging area to the aircraft. Once placed on the truck, the pallets can be positioned with little effort, thus eliminating the need to use



463-L PALLET



40K LOADER

forklifts and other MHE to move the pallets again. The roller bed of the trucks may be raised or lowered to the height of the aircraft floor. The pallets can be then pushed into the aircraft from the truck.

The final element of the 463-L system is the aircraft itself. All of the Air Force cargo aircraft have been modified to have a roller and locking system on their cargo floors. The rollers are normally stowed out of the way; but when they are needed, they can be quickly installed and put to use. The loaded pallets are simply

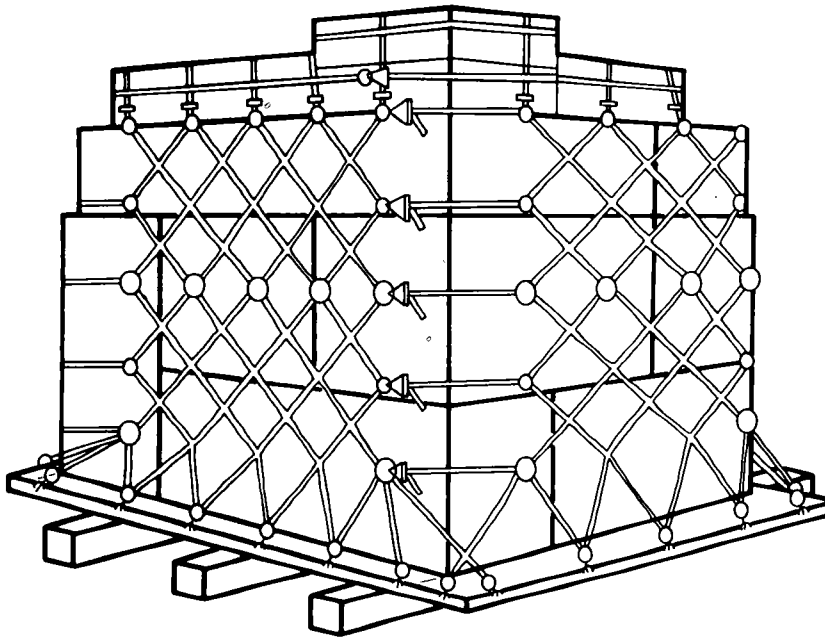
ROLLER LAND RAIL SYSTEM



pushed off the truck onto the aircraft rollers, pushed to a pre-designated fuselage station, and locked into place. No further cargo restraint is necessary, since the pallet and its associated nets provide all the restraint necessary. When the aircraft arrives at its destination, the pallet is unlocked and pushed off the aircraft onto another roller-equipped truck, and the aircraft can be flying again in a matter of minutes.

As versatile as the pallet system is, it does require some effort to use it properly. Cargo cannot be simply stacked on the pallet and then placed aboard the aircraft; it must be restrained by attaching it to the pallet. To prevent the cargo from moving forward, backward or side-to-side, side nets must be placed around the cargo. These nets hook into rings around the pallet and then into each other. They are drawn tight and a top net is placed over the cargo to prevent the cargo from moving vertically. The top net is attached to rings in the side nets, then drawn tight. When properly installed, the nets will restrain the cargo from moving just as if it were tied down to the floor of the aircraft.

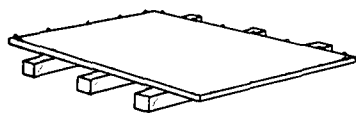
Pallets are available to Army units planning or executing an air movement through the affiliated ALCE or Air Force representative. If your unit does not have enough cargo vehicles to carry all of the equipment that must be shipped, you will probably use Air Force vehicles. In that case, you should use the pallets; otherwise, the Air Force may not accept your cargo for air transport.

**PALLETIZED CARGO**

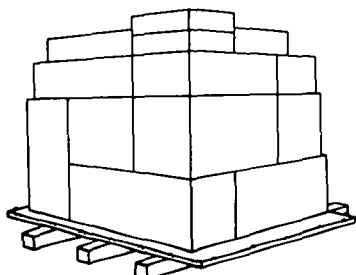
To load the pallet, stack the items on the pallet so the heaviest items are at the center of the pallet and on the bottom of the stack. Stack other items around these until you have reached 10,000 pounds or used all the available space on the pallet. Do not allow the cargo to hang over the edge of the pallet. As a safety factor, do not stack the cargo any closer than 2 inches from the edge of the pallet; that is, not over the seam that runs around the edge of the pallet. If you do not observe this rule, it could result in the last minute reloading of the pallet, or in the elimination of your equipment from the vehicle. That could mean that you would have to do without something you really need when you get to your final destination.

Before using the nets, lay out the side nets and inspect them for serviceability. Do not use any nets that are torn or rotted, or have bad hooks. Only one bad strap in all of those on the net is enough to make the entire net unserviceable.

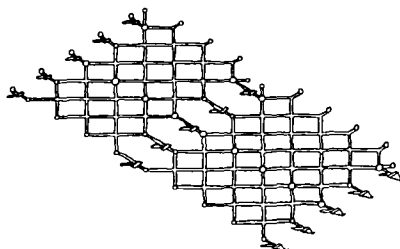
Make sure that you have identified which is the long side and the short side of the net, and that the net is right-side-up. The net



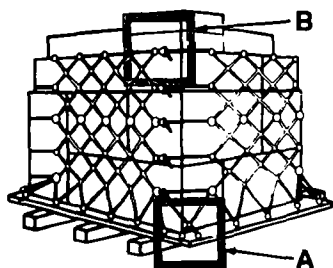
EMPTY PALLET



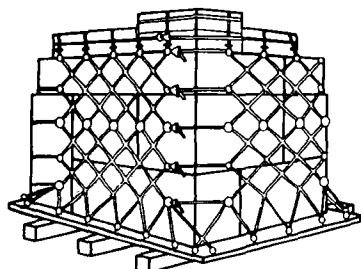
LOADING PALLET



INSPECT NETS



PUT ON SIDE NETS



TOP NET

PALLET LOADING STEPS

must be right-side-up so the bottom hooks will be pointing inward after the nets have been attached to the pallet. The long side of the net has six hooks, and the short has five hooks. If the net is right-side-up, the hooks will be facing down as the net is lying on the ground. In addition, many of the nets are marked "OUT-SIDE."

Place the two bottom nets around the cargo on the pallet, and hook the hooks into the pallet rings as shown. Make sure that the straps at the corners of the net cross at the corners of the pallet. Pull the net as high as it will go and hook the two bottom nets together. Make sure the hooks face **out**; otherwise, you may damage the cargo.



Place the top net over the cargo, making sure it is centered. Again, making sure the hooks are **out**, hook the top net into the side nets. Always use the same row of rings on the bottom nets to insure that the top net pulls evenly. When the top net is hooked in, pull evenly on all the straps to tighten the top net. Two people should do this, to insure that the net stays even. When all the straps are tightened, tie all the loose ends into the net, so they won't snag on something on the aircraft. The load is now ready to go.

It is important to load and net the pallets properly. It must be done correctly to make the pallet airworthy. Prior planning is the key. A sufficient number of personnel in your unit must be trained to do the job. **The most prevalent reason cargo is bumped or delayed from an aircraft is poor pallet build-up or netting.**

These pallets can be moved with a forklift, but 72-inch lifting arm extenders will be required on most Army forklifts to avoid having them tip over. When placing the pallet on the ground, place dunnage under it. Three 4- by 4- by 8-inch boards are best, but sandbags will work. Insure that the pallet is supported in three places to prevent it from bending. **Do not** try to push the pallet along the ground with a forklift nor try to lift it without getting under it with the forklift arms. Damage to the pallet is quite likely under these conditions. Such damage would make it necessary to transfer the load to another pallet, with a resultant loss of time for reloading, and added expense for damage to the pallet.

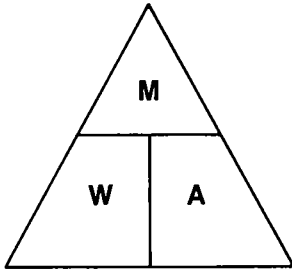
The 463-L pallet and its associated cargo handling system can be an important part of the movement plan. When used properly, they can simplify many cargo handling problems. Through advance coordination with your affiliated ALCE, it may even be possible to have some of your loads made up well in advance of any movement or exercise, thus simplifying your actual movement process.

WEIGHT AND BALANCE

Aircraft have crashed because weight and balance was neglected or incorrectly computed. Correct loading of cargo, properly balanced in an aircraft, is of prime importance to a safe flight. Certain recommended limits and data are shown for each type of aircraft in chapter 2. You should be thoroughly familiar with all aspects of aircraft weight and balance so you can insure safe and efficient movement of your unit by air. You should also know how cargo center of balance (CB) affects aircraft loading and planning.

PRINCIPLES OF MOMENT

To understand balance, it is necessary to have a working knowledge of the principles of moment. Moment is simply the product of a force (or weight) times its distance from the reference datum line. The distance used in calculating a moment is referred to as the arm, and is usually expressed in inches. To calculate moment, a force (or weight) and distance must be known. The distance is measured from some known point (reference point or reference datum) to the point through which the force acts. Moment is meaningless unless the reference point about which the moment is calculated is specified.



$$\text{MOMENT} = \text{WEIGHT} \times \text{ARM}$$

$$\text{WEIGHT} = \frac{\text{MOMENT}}{\text{ARM}}$$

$$\text{ARM} = \frac{\text{MOMENT}}{\text{WEIGHT}}$$

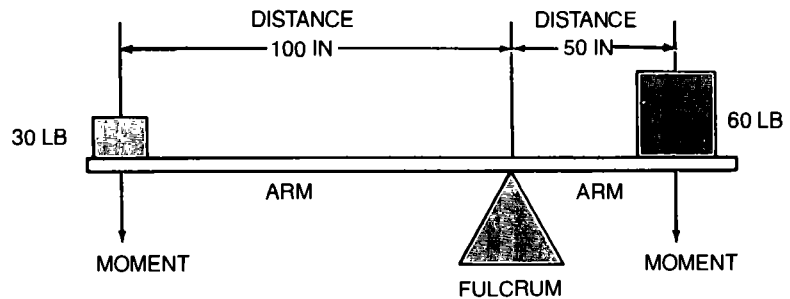
There are three items used in weight and balance calculations: moment, weight, and arm. The relationship of these terms can be shown by arranging them in a mathematical triangle.

Perhaps the simplest way to explain this is to look at a child's see-saw, where a heavy board is placed across a fixed support about which the board balances (fulcrum). When there are two different sized children riding the see-saw, they use their skill or intuition to make it operate properly. They do this by compensating with distance: the heavier child sits closer to the fulcrum and the lighter child sits farther away from the fulcrum.

EXAMPLE 1

Looking at the following illustration, you see a board perfectly balanced with a 30-pound weight on one end and a 60-pound weight on the other. This example illustrates that the influence of weight depends directly on its distance from the fulcrum; so that for balance to exist, the weight must be distributed so the leverages or turning effects are the same on each side of the fulcrum. Note that the heavy weight near the fulcrum has the same effect as a lighter weight farther from the fulcrum.

BALANCED BOARD



To prove mathematically that the see-saw board is balanced, apply the formula shown at the left to determine whether or not the moments applied to each opposite side of the fulcrum are equal.

Left Side

$$\begin{aligned} W &= 30 \text{ pounds} \\ A &= 100 \text{ inches} \\ M &= W \times A \\ &= 30 \times 100 \\ &= 3,000 \end{aligned}$$

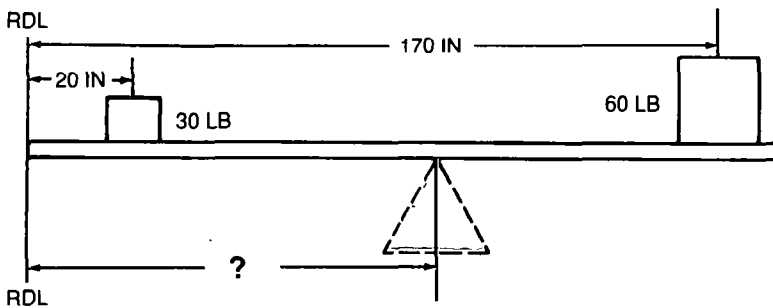
Right Side

$$\begin{aligned} W &= 60 \text{ pounds} \\ A &= 50 \text{ inches} \\ M &= W \times A \\ &= 60 \times 50 \\ &= 3,000 \end{aligned}$$

Substituting the values from the above example into the formula, we can see that each side has a moment of 3,000, and the see-saw board is perfectly balanced.

EXAMPLE 2

If the fulcrum is unknown and we have the same see-saw board, with the same weights as in example 1, the problem is one of determining the location of the fulcrum, or the CB. In order to find the fulcrum, apply the same formula as described in example 1, but first measure some distances (arm) so that you can find the appropriate moment for each weight. To measure distance, you need a specific known starting point, or reference point. These measurements may be made from any point, but in this example, the left end of the see-saw board will be our reference point or reference datum (RD).



UNKNOWN BALANCE POINT

Assume the distance for each of the weights on the see-saw board from the RD line measured 20 and 170 inches respectively. You will note that the distances are measured from the RD to the center of mass or CB of each of the weights. Using the same formula again, let's compute the moment:

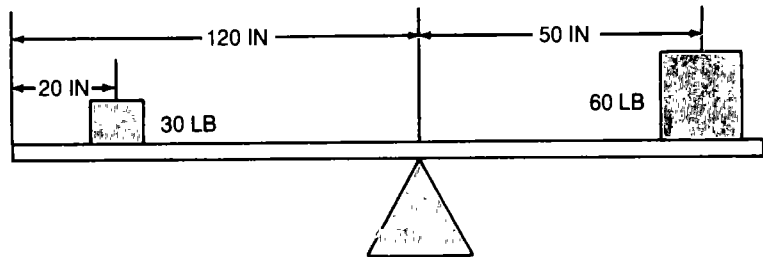
Weight	×	Arm	=	Moment
30 pounds	×	20	=	600 inch-pounds
60 pounds	×	170	=	10,200 inch-pounds
90 pounds				10,800 inch-pounds

Add the weights and the moments (inch-pounds) as shown above. Now, to find the distance to the center of balance (fulcrum) in this example, all we need to do is divide the total moment by the total weight.

$$\frac{\text{Total Moment}}{\text{Total Weight}} = \text{Arm or } \frac{10,800}{90} = 120 \text{ inches}$$

Therefore, the center of balance (fulcrum) of this see-saw board is 120 inches from the RD line.

BALANCED BOARD



Again, to prove mathematically that each side of the see-saw board is subjected to the same moment, and therefore is balanced, we calculate as follows:

Left Side

$$\begin{aligned} A &= 120 - 20 \\ &= 100 \end{aligned}$$

$$\begin{aligned} M &= W \times A \\ &= 30 \times 100 \\ &= 3,000 \end{aligned}$$

Right Side

$$\begin{aligned} A &= 170 - 120 \\ &= 50 \end{aligned}$$

$$\begin{aligned} M &= W \times A \\ &= 60 \times 50 \\ &= 3,000 \end{aligned}$$

Since the same moment or leverage (3,000 inch-pounds) is applied to each side, the see-saw board is in balance.

LOAD CENTER OF BALANCE

In some older publications, the term center of gravity or CG is widely used in conjunction with aircraft loads (cargo). This term is the same as load, or cargo center of balance, or CB. Since balance of the aircraft is primarily affected by weight variations along the longitudinal axis of the cargo inside the aircraft, as explained above, the term "CB" is more appropriate when referring to the balance point of items of cargo or equipment that go into the aircraft.

GENERAL CARGO CENTER OF BALANCE COMPUTATION

The CB of general cargo (cargo other than vehicles) may be found by one of two methods.

1. Balance the package (item) on a roller and mark the balance point.
2. Weigh one end of the package on a suitable scale, while supporting the opposite end as near the edge as possible.

The location of the balance point is then calculated by the following formula:

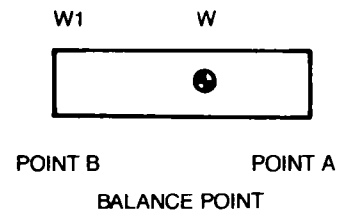
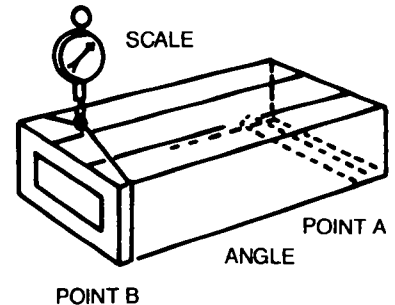
$$L_1 = \frac{W_1 \times L}{W_T}$$

where: W_T = total weight
 W_1 = scale reading
 L = distance between supports (inches)
 L_1 = distance from fixed support to center of balance (inches)

To figure the CB of a 600-pound box, 40 inches long, the formula would look like this:

$$L_1 = \frac{300 \times 40}{600}$$

which gives us a center of balance of 20 inches.



LOCATING CENTER OF BALANCE BY USING A SCALE

VEHICLE CENTER OF BALANCE COMPUTATION

Now that you know the principles of center of balance computation, you must apply them to the cargo that you will be loading into the aircraft. The easiest way to find the center of balance of a piece of cargo is to put it on a narrow edge and mark the place where it balances. The easiest way to find the center of balance of a tracked vehicle is to drive it onto a large log and mark the place where it begins to tilt forward.

For most cargo and vehicles, it is not possible to find the center of balance without weighing and measuring the load.

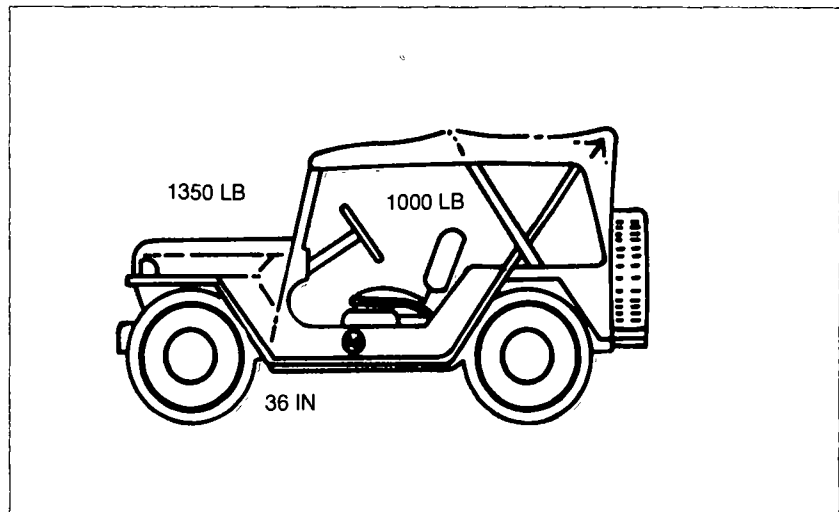
In the case of vehicles, the weight on the front wheels and the weight on the rear wheels are different, and should be separately found by driving the vehicle onto a scale.

To find the center of balance location of a vehicle, multiply the rear axle load by the wheelbase length (the distance between the centers of the two axles) in inches and divide by the gross weight of the vehicle. The resulting figure is the number of inches you must measure aft from the centerline of the front axle to locate the center of balance of the vehicle. Shown as a formula, it looks like this:

$$\frac{W_1 \times L}{W_G} = CB$$

Where

W_1 = rear axle load
 L = wheelbase length
 W_G = gross weight

EXAMPLE 3

The weights and dimensions of the vehicle shown above are:

Gross weight	2,350 pounds
Front axle load	1,350 pounds
Rear axle load	1,000 pounds
Wheelbase of vehicle	85 inches

Multiply the rear axle load (1,000 pounds) by the wheelbase length (85 inches), and divide by the gross weight of the vehicle (2,350 pounds). Substituting in the formula, it looks like this:

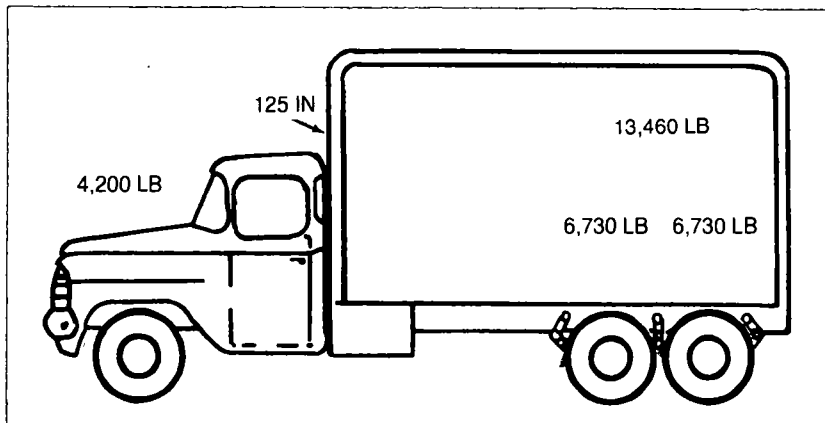
$$\frac{W_r \times L}{W_g} = CB$$

$$\frac{1,000 \times 85}{2,350} = 36 \text{ inches}$$

Some people may find it easier to write it down as a table; it will look like this:

	Weight	×	Arm	=	Moment
Front axle	1,350	×	0	=	0
Rear axle	<u>1,000</u>	×	85	=	<u>85,000</u>
Totals	2,350				85,000

$$\frac{85,000}{2,350} = 36.17$$

EXAMPLE 4

The weights and dimensions for the vehicle shown above are:

Gross weight	17,660 pounds
Front axle load	4,200 pounds
Each rear axle load	6,730 pounds
Total rear axle load	13,460 pounds
Wheelbase of truck	164 inches

Multiply the total rear axle load (13,460 pounds) by the wheelbase length (164 inches), and divide by the gross weight of the vehicle (17,660 pounds).

$$\frac{W_r \times L}{W_g} = CB$$

$$\frac{13,460 \times 164}{17,660} = 125 \text{ inches}$$

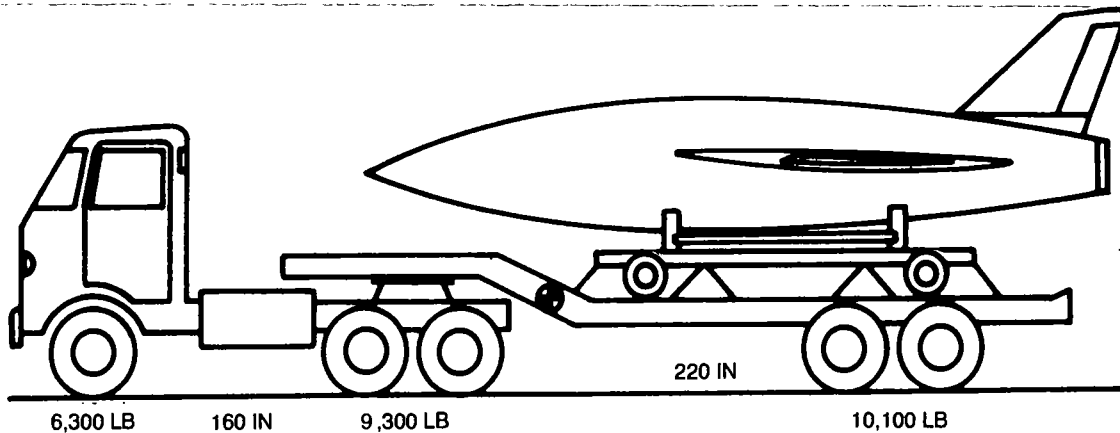
In table form the computations look like this:

Weight	×	Arm	=	Moment
Front axle 4,200	×	0	=	0
Rear <u>axles 13,460</u>	×	164	=	<u>2,207,440</u>
Total 17,660				2,207,440

$$\frac{2,207,440}{17,660} = 124.99$$

$$CB = 125 \text{ inches}$$

The center of balance of the vehicle is located 125 inches aft of the centerline of the front axle.

EXAMPLE 5:

The weights and dimensions for the tractor-trailer shown above are:

Front axle load	6,300 pounds
Center axle load	9,300 pounds
Rear axle load	10,100 pounds
Total weight	25,700 pounds
Front axle to center axle wheelbase	160 inches
Center axle to rear axle wheelbase	220 inches
Total wheelbase	380 inches

Multiply the center axle load (9,300 pounds) by the wheelbase (160 inches) from the front axle centerline to the centerline of the center axle. Then multiply the rear axle load (10,000 pounds) by the total wheelbase (380 inches). Add the two figures and divide the sum by the total vehicle weight (25,700 pounds.)

In table form, the computations look like this:

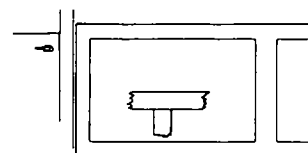
	Weight	×	Arm	=	Moment
Front axle	6,300	×	0	=	0
Rear axle	9,300	×	160	=	1,488,000
Trailer axle	10,100	×	380	=	3,838,000
Totals	25,700				5,326,000

$$\frac{5,326,000}{25,700} = 207.23$$

$$CB = 207 \text{ inches}$$

Thus, the center of balance for the tractor-trailer combination (including the cargo load) is 207 inches aft of the front axle centerline.

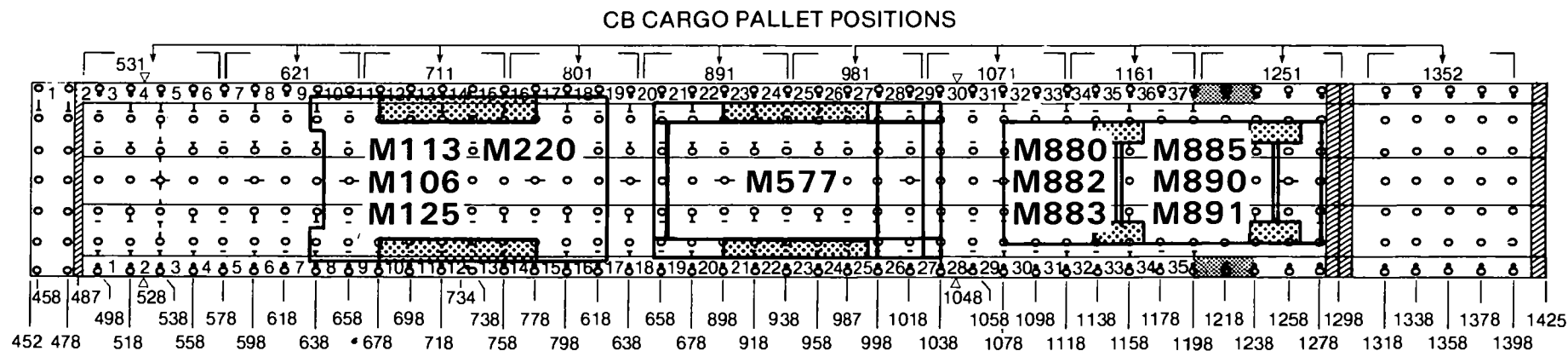
After you have measured and weighed your vehicles, mark the CB as accurately as possible with masking tape and a grease pencil or waterproof ink. Avoid the use of chalk or any marking method that could be easily washed or rubbed off. Place the tape on the vehicle in a "T" shape, and draw a line on it with the grease pencil at the **exact** CB of the vehicle. On the top of the "T", write the **total weight** of the vehicle. If you are marking a combined CB, write the **combined weight** on the tape. Mark the weight of each axle similarly and place the tape above the wheel.



TAPE MARKING

AIRCRAFT CENTER OF GRAVITY (CG)

The point around which the aircraft will balance is called center of gravity. To obtain proper balance of an aircraft, the load must be placed precisely, so the balance point of the loaded aircraft is within the allowable CG range of that aircraft. The exact position of the CG is expressed in inches, measured rearward from the reference datum line (RDL). The RDL is an arbitrary reference point at or near the nose of the aircraft, used as the starting point to identify fuselage station numbers which are clearly marked along the floor and sides of the cargo compartment. The fuselage station numbers are precise locations you must use to place cargo.

C-141A AIRCRAFT FLOOR
DIAGRAM

To maintain the balance of small aircraft (such as a two-seater liaison plane or a fighter plane) is comparatively simple, because most of the weight is fixed. With transport planes, however, a large percentage of the aircraft weight is variable. Cargo, equipment, passengers, and fuel all play an important part in maintaining the balance of the aircraft; therefore, precise placement of the loads must be determined by mathematical calculations.

The theory of aircraft weight and balance deals mostly with balance along the longitudinal (fore and aft) axis of the aircraft. Lateral (side to side) and vertical (up and down) variations created by loading an aircraft are small because of the relatively small cross section of the fuselage.

Aircraft balance is determined by the relationship of the center of gravity to the center of lift. The ability of the aircraft to fly depends on the location of the CG. If the CG is out of limitations, the aircraft will be unable to fly. As fuel, cargo, passengers, and other weights are added, removed, or relocated within the aircraft, the aircraft CG changes. The aircraft is designed to permit such changes in flight provided the CG location remains within certain specified limits (see chapter 2).

AIRCRAFT CENTER OF GRAVITY COMPUTATION

After you have decided what is to go on each aircraft, you must compute the aircraft weight and balance to insure that the limits of the aircraft have not been exceeded. To do this, you must know:

- Weight of each vehicle or piece of equipment
- Fuselage station of each vehicle or piece of equipment
- Ready for loading (RFL) weight of the aircraft
- RFL fuselage station of the aircraft.

The last two figures will not be known until the actual aircraft assigned to move the load arrives, so you will have to use the general planning figures given in chapter 2.

The formula for finding the aircraft CG is the same as for vehicle B. To find the arm, the final CG of the loaded aircraft, add all the weights and moments of the cargo and the empty aircraft, then divide the total moment by the total weight to get the final CG. If that CG is within limits for that aircraft, the load is acceptable. If the CG is not within the CG limits of the aircraft, then you will have to move some of the cargo items and do the calculations over again.

$$\text{Weight} \times \text{arm} = \text{moment}$$

or

$$W \times A = M$$

$$\text{Weight} \times \text{arm} = \text{moment}$$

or

$$W \times A = M$$

EXAMPLE

A C-141A load with the following weights and fuselage stations has been developed:

Item	Wt	×	Fus Sta	=	Moment
Trk, CGO, 2½ T M35AZ	14,300	×	675	=	9,652,500
Car FTA, M113A1	20,120	×	935	=	18,812,200
Trk, CGO, 2½ T M35A2	17,500	×	1109	=	19,407,500
Acft RFL Wt & Fus Sta	<u>233,000</u>	×	939.1	=	<u>218,810,300</u>
Total Wt and Moment	284,920				266,682,500

$$\frac{\text{Moment}}{\text{Weight}} = \text{CG Arm}$$

$$\frac{266,682,500}{284,920} = 935.99$$

The final CG of this aircraft load is 936. The tables in chapter 2 show the CG limits of a C-141A as 917.4 to 946.6, so this load is acceptable and will not endanger the aircraft.

On most aircraft loads designed by a unit air movements planner, personnel weight and arm will have to be included in the aircraft load computation. Personnel should be seated all together, as you will rarely have to fill all the seats available, and their CB should be figured from the fuselage station closest to the center of the mass.

Whenever possible, seat personnel in directly opposite seats. If personnel seats are staggered on either side of the aircraft or in no particular pattern, the CB of **each group** will have to be included. The closer together personnel are seated in the aircraft, the fewer computations will have to be done to determine the aircraft CB.

Loaded pallets do not need a separate CB measurement and marking unless they are of unusual configuration. The loaded pallet will have to be part of your aircraft CG computation, but the fuselage stations for the pallets are identified in the aircraft along the top of the diagrams on the DD Forms 2130, 2131, and 2132, and MAC Form 559. Pallets should not be placed on any other fuselage station except those so identified.

PLACEMENT OF AIRCRAFT LOADS

LOAD PLANNING

Boxes, crates, pallets, and other relatively small items are easy to load into an aircraft, but still require a plan on how and where they should be placed inside the aircraft. Wheeled vehicles, trailers, tracked vehicles, and other large equipment, however, require much greater planning effort.

The development of an aircraft load requires precision and a knowledge of the principles of centers of gravity and balancing. Once you understand these principles, you can easily and quickly plan aircraft loads without complicated mathematics.

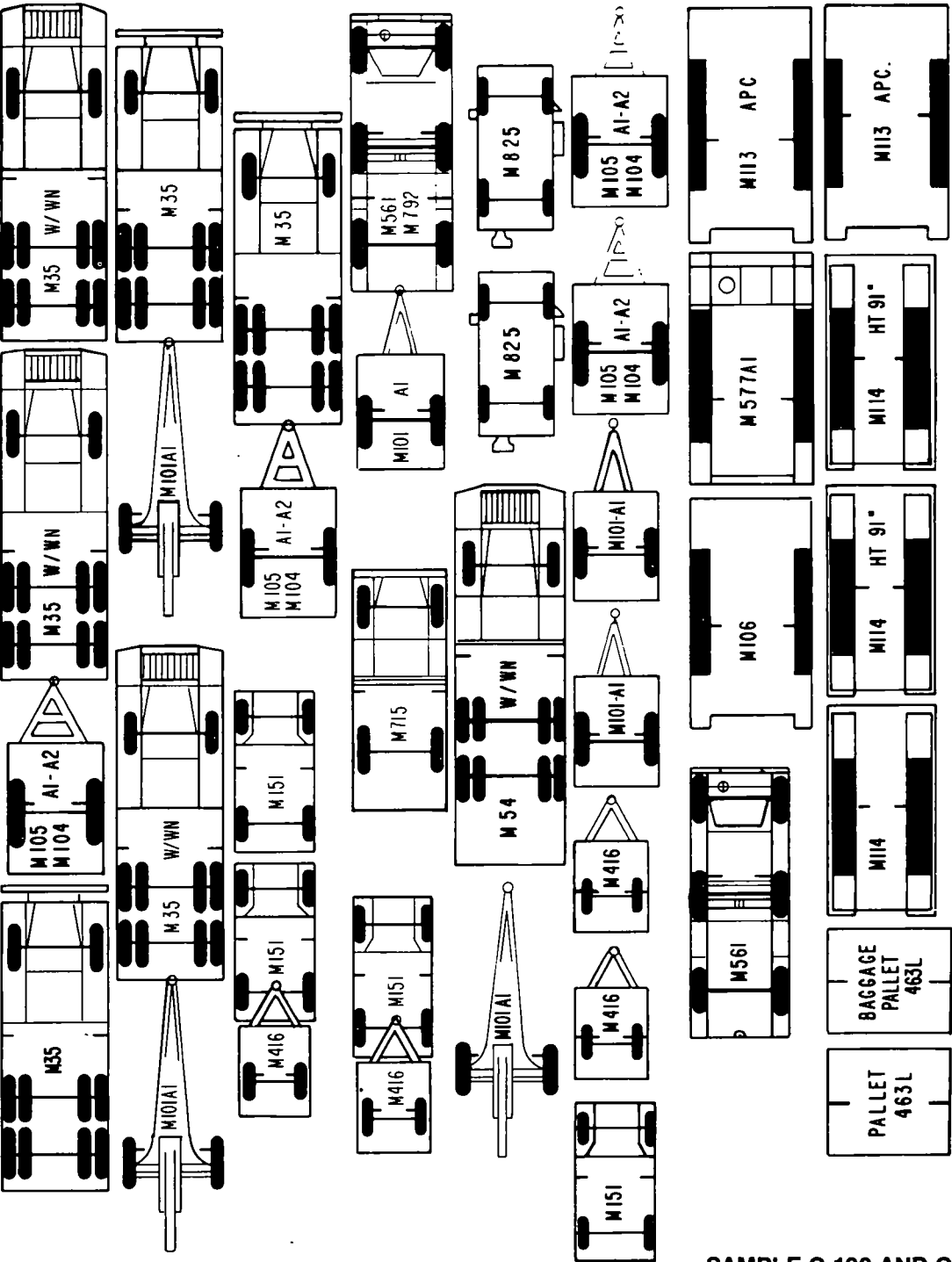
You should place the center of balance of the heaviest item at the optimum CG station of the aircraft. The next heaviest item is placed forward of the first item, the third item is placed aft of the first, and so on. This is called the **pyramid** method of loading; it is used to quickly plan the placement of vehicles and other heavy equipment onto aircraft.

You should verify your estimated plan after you have decided upon which fuselage station to place your equipment. Using this method, together with the templates and scale drawings of the aircraft floor plans, you can quickly change or reconfigure aircraft loads without time-consuming figuring. Be sure that your affiliated ALCE representative approves your final plan. It is an Air Force responsibility to insure that the fuselage station computations are correct.

The aircraft load must be within the aircraft center of gravity designated units. All cargo aircraft are designed to be loaded; in fact, some will fly better when loaded than when empty. Load planning may be easier to understand if you picture the empty aircraft as a large rectangle and the cargo and vehicles as smaller rectangles. You simply fit the smaller rectangles into the larger one in the easiest way possible, keeping in mind the principles of balance given above.

USE OF TEMPLATES

The best way to plan your load placement is to obtain scale drawings or templates of all the vehicles in your unit. To do this,



SAMPLE C-130 AND C-141A
TEMPLATES

use the examples in this manual or contact your affiliated ALCE, who can supply a master template for most of the vehicles in the Army inventory. You can use the master and reproduce the parts you need, returning the master to the ALCE. Do not overlook height measurements, particularly if height dimensions approach the maximum height limitation of the aircraft cargo compartment.

The aircraft cargo compartment floor plan on DD Forms 2130, 2131, 2132, and MAC Form 559 is shown with these scales:

C-5	$\frac{1}{4}" = 3 \text{ feet}$
C-130	$\frac{1}{8}" = 1 \text{ foot}$
C-141A	$\frac{1}{8}" = 1 \text{ foot}$
C-151B	$\frac{1}{4}" = 3 \text{ feet}$

NOTE: You cannot use the same templates for a C-5 and C-141B as you do for the C-130 and C-141.

Use the pyramid loading technique to place each template on a specific fuselage station number on the floor plan diagram. There is no reason to put vehicles in any particular order; there is no "right way" to load an aircraft. If the load you plan **does not exceed the aircraft CG and weight limits**, and all the vehicles and equipment will **fit into the space you have designated**, you have done it correctly. Remember, vehicles should be **backed** into the aircraft. If you reverse the templates when planning the load, your CG figures may not be correct.

The templates, when properly positioned on the cargo compartment diagram on DA Form 2130, 2131, 2132, or MAC Form 559, will assist in the efficient load planning and will insure maximum use of cargo space. The spacing of vehicles should allow sufficient room for attachment of the tiedowns (at least 10 inches apart). After positioning of the cargo and vehicles, compute the aircraft CG to verify whether the aircraft balances within the desirable CG limits.

LOADING PROCEDURES

Cargo and equipment that can be transported by aircraft come in many sizes and various configurations. Because of that, a variety of loading techniques is possible. The ultimate decision of how cargo is to be loaded and positioned aboard an aircraft is an

Air Force responsibility. Loading is normally accomplished by the deploying unit, assisted as necessary by departure/arrival control group (DACG) personnel and equipment, and supervised by an Air Force loadmaster. However, prior planning is the key; and aircraft load planning is the moving unit's responsibility.

The 55-series Transportability Guidance Manuals provide guidance on loading certain specific items of equipment or systems. TB 55-45 provides an authenticated source of information regarding military equipment certified for transport in Air Force and CRAF aircraft. It is also helpful as a reference for air movement planning and operations at all levels of command. TB 55-46-1 defines vehicle dimensions and weights for all Army equipment, in operational as well as reduced (shipping) configuration. These publications should be referred to by all deployment planners in conjunction with their unit deployment planning.

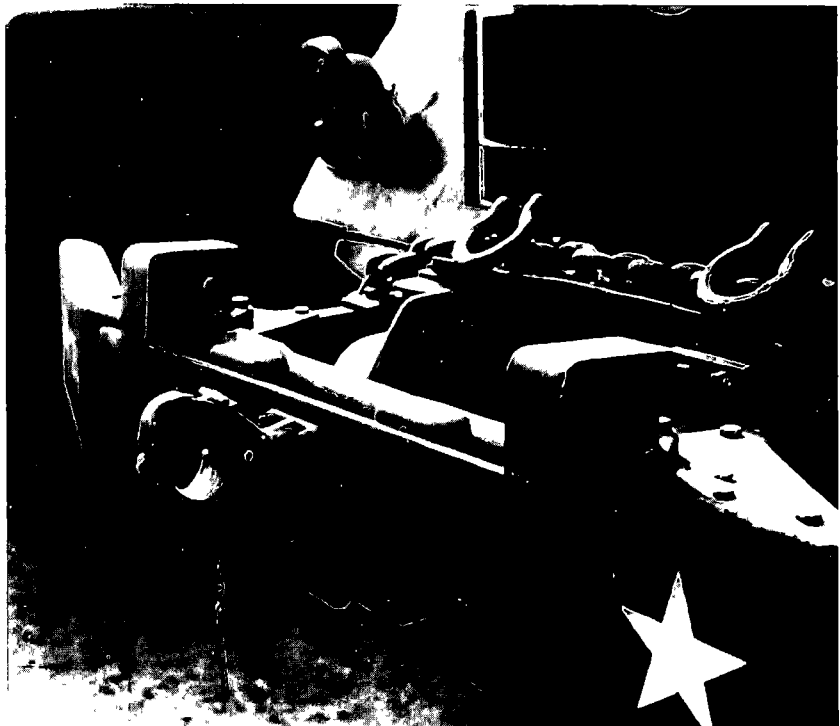
You should follow the prescribed procedures for loading a particular item of equipment. If there are any problems, the loadmaster assigned to the aircraft will be the final authority for solving them. In the process of loading an aircraft, and depending on what type of cargo or equipment is to be loaded, there may be only one single, distinct method to be used or there may be a combination of many. Some of the loading methods are as follows.

- **Direct loading from vehicles.** Cargo is delivered directly to the aircraft by a vehicle. The vehicle is positioned close to the aircraft ramp door, permitting direct transfer of the cargo from the vehicle to the aircraft cargo compartment.
- **Drive-in/drive-off method.** The vehicle or prime mover is driven or backed under its own power into the aircraft cargo compartment. This method is generally the easiest to use when loading vehicles, and is also used for vehicles with towed loads, and for tractor-trailer units.
- **Towed loads.** Certain loads, such as trailers, must be towed or backed aboard the aircraft either by a prime mover or by manhandling. If the towed load remains with the prime mover aboard the aircraft, the trailer may or may not remain hitched to the prime mover inside the aircraft. To conserve

space, the trailer may be uncoupled; in that case, the tongue will normally be lowered on the aircraft floor and under the prime mover.

NOTE: Care must be taken to insure that proper shoring is placed under the tongue to prevent damage to the aircraft floor.

- **Pushed loads.** Some loads may be pushed aboard the aircraft either by manhandling or by a pusher vehicle. This method is particularly helpful in pushing large trailers aboard the aircraft, because the driver can more easily control the operation. A pusher vehicle must be equipped with a pintle hook that is attached to the front bumper of the vehicle. Standard Army vehicles are not equipped with such a device; consequently, a unit may have to fabricate one, using scrap iron and a salvaged pintle hook.



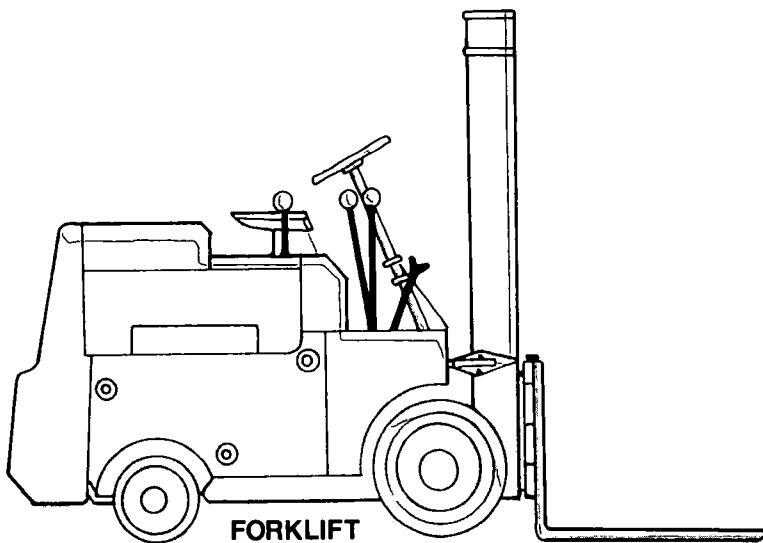
PUSHER VEHICLE

- **Winched loads.** It may be necessary to winch wheeled or tracked vehicles, and skid-mounted or palletized cargo into the aircraft cargo compartment. The winching method is particularly useful where cargo compartment clearances and ramp inclines are critical. You may also use the winch

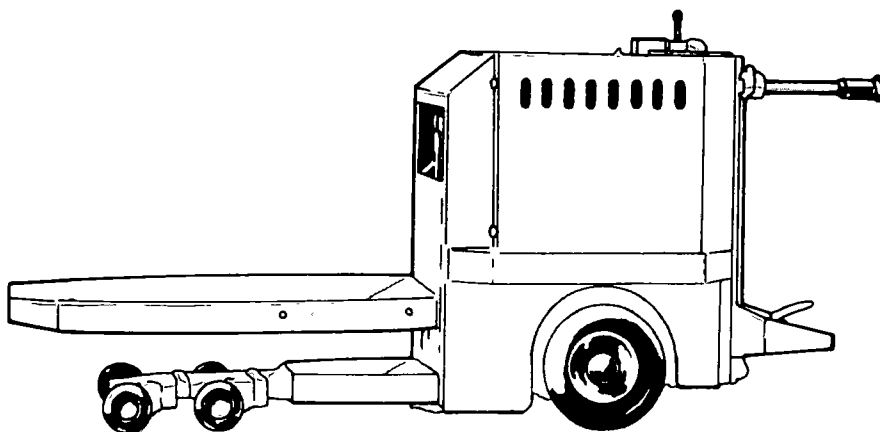
to unload cargo or vehicles to provide necessary restraint and control when the cargo is moved down the aircraft ramp.

◦ **Loads that require materials handling equipment (MHE).**

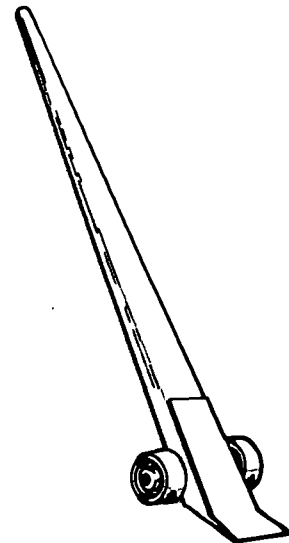
To speed up loading, a number of devices have been developed to insure rapid loading and unloading of aircraft. The most common of these are forklifts of various capacities, two-wheeled and four-wheeled hand trucks, roller devices, warehouse trailers, tugs, platform trucks, gravity rollers, power conveyors, and pry bars.



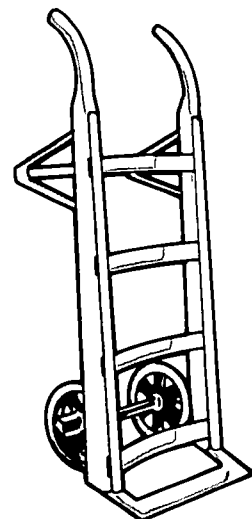
FORKLIFT



PLATFORM TRUCK

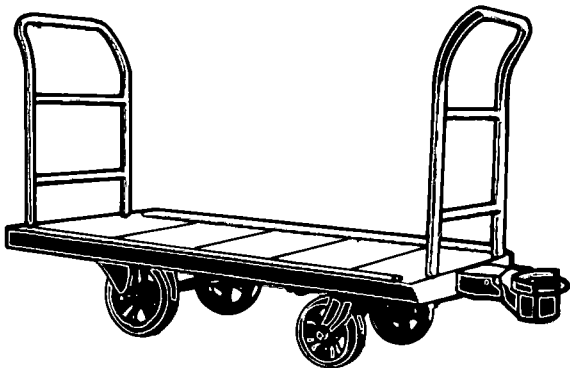


PRY BAR

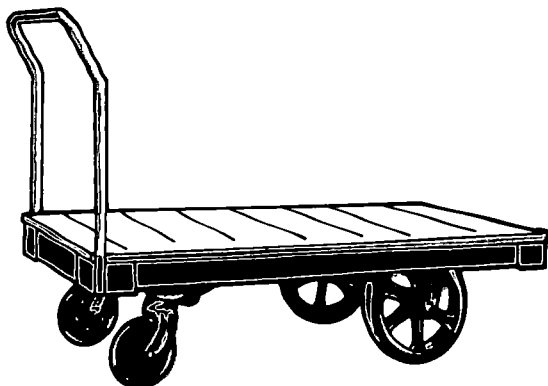


TWO-WHEELED TRUCK

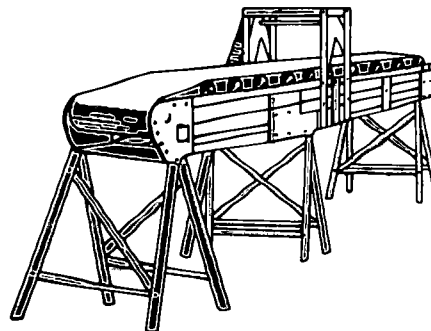
MATERIAL HANDLING EQUIPMENT



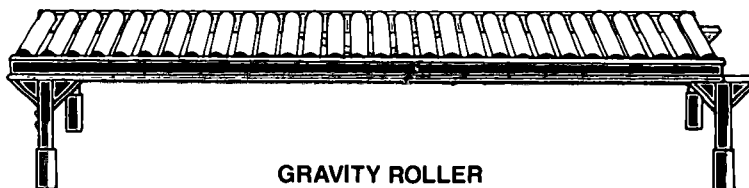
WAREHOUSE TRAILER



FOUR-WHEELED TRUCK



POWER CONVEYOR

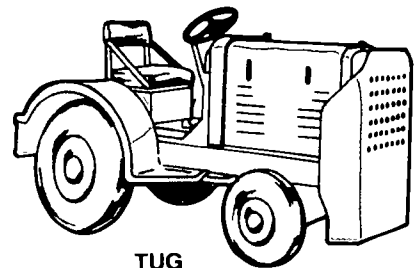


GRAVITY ROLLER

MATERIAL HANDLING EQUIPMENT



ROLLER DOLLY



TUG

MATERIAL HANDLING EQUIPMENT

Common loading aids provided by the Air Force are the various K-loaders (truck, aircraft, and cargo type A/S 32H-series). These loaders, part of the 463L materials handling support system, come in three sizes (rated capacities): 25,000, 40,000, and 55,000 pounds. In addition to the K-loaders, 6,000- and 10,000-pound capacity forklifts can be used, if supplied by the deploying unit or DACG/ALCE, to handle single 463L pallets.

SUMMARY

Aircraft load planning requires a type of specialized knowledge you will not find in any other Army professional field. You have to know some of the fundamentals of aircraft design as well as some basic physics, such as the laws of moments. You must know how to weigh and mark your vehicles so they will be ready to be transported by Air Force aircraft.

You will have to know how to determine aircraft center of gravity to insure that your load is safe to fly. You have to know enough about the aircraft itself to be able to know what can be loaded and what cannot be loaded. Further, you will have to know the various loading techniques, and how your equipment will go onto an aircraft.



CHAPTER 6

UNIT AIR MOVEMENT PLANNING

Unit air movement planning is the first and most important step to deploying your unit with the least possible difficulty. To prepare aircraft loads, you must understand the basic principles for such planning. Think of the aircraft as a large rectangle and all your vehicles and cargo as smaller rectangles. Then, it is merely a matter of finding where the smaller rectangles best fit. Using the center of balance (CB) and aircraft center of gravity (CG) figures in chapter 5, combine these figure with what you learned about aircraft characteristics in chapter 2. You need only to compute your aircraft loads according to the principles discussed in this chapter.

DETERMINING AIRCRAFT REQUIREMENTS

Your unit standing operating procedure (SOP) should specify the order in which personnel and equipment of the unit will be moved by air. Planning guidance from higher headquarters will indicate the type of aircraft available for the movement. Based on this information, you can determine and request the number of sorties, by type of aircraft, required to complete the move.

To plan the airlift movement itself, you should first know exactly how many personnel and what equipment are to be moved.

Secondly, you should be aware of some of the characteristics of the aircraft that will carry the load. Specific details on aircraft information and other technical assistance may be obtained at any time during the planning process from the supporting MAC units or through the affiliated airlift wing or unit.

Before submission of the request for the number of aircraft needed, you must insure that each aircraft will be used to its maximum capability. This is based on the information that has been developed, including applicable allowable cabin loads (ACL) and available passenger seats. When ACL and passenger seat availability are not known, you can use the data in chapter 2 for advance planning.

CONTENTS

DETERMINING AIRCRAFT REQUIREMENTS
AIR MOVEMENT DATA
FORMS REQUIRED
STEPS IN AIR MOVEMENT PLANNING
MANIFESTING
TEST LOADING
SUMMARY

There are two methods of determining aircraft (sortie) requirements:

- Weight Method
- Type-Load Method

Weight Method. The weight method is used for calculating sortie requirements to transport large amounts of supplies, general cargo, and personnel. This method is based on the assumption that total weight and not volume is the determining factor. To give a general idea of aircraft requirements for a planned move, high level planners use the weight method. It is no longer widely used, however, because of its general inaccuracy and has been mostly superseded by the type-load method and the use of MAC forms 551 and 552.

Type-Load Method. In any unit air movement, a number of the aircraft loads will contain the same items of equipment and numbers of personnel. Identical type-loads greatly simplifies the planning process and makes the tasks of manifesting and rehearsal much easier. Used for calculating individual aircraft sortie requirements, the type-load method is the most common and most widely accepted method of unit air movement planning. The method requires consideration of load configuration and condition upon arrival at destination, rapid offloading, aircraft limitations, security requirements en route, and the anticipated operational requirements. The type-load method, therefore, is more detailed and is normally used in planning unit movements.

To properly employ the type-load method, some factors relating to safe loading and aircraft restraints must be considered. These include unusual characteristics of the equipment to be loaded, aircraft compartment restrictions, accurate weights and dimensional data, marking of major items of equipment to show weight and center of balance (CB), and special arrangements of some cargo within the space limitations of cargo compartment.

AIR MOVEMENT DATA

There are two formats you can use for unit air movement plan. One is an air movement planning work sheet, and the other is a basic planning guide. There are two forms designed to complete an air movement plan; namely, Unit Aircraft Utilization and Air Loading Table.

AIR MOVEMENT PLANNING WORK SHEET

An air movement planning work sheet can be used to prepare a consolidated list of all your unit equipment and personnel. An example of such a work sheet is displayed below. On it you will list all the dimensions and cargo loads of your vehicles. First, measure and weigh your vehicles as shown in chapter 5 to insure that they have not been modified from the standards listed in TB 55-46-1. Next, see your unit property book, which lists the proper Army nomenclature for your vehicles and tells you if you have the full authorized amount of equipment. To find how many items of equipment you are authorized, refer to your unit TO&E. Even if your unit is short some equipment, include them in your

AIR MOVEMENT PLANNING WORK SHEET

[illegible]

(Suggested Format)

4804-7

Air Movement Plan. When your unit deploys or is alerted to deploy, the equipment shortages will usually be filled. Refer to your vehicle load cards to find how much cargo is loaded into each cargo truck.

BASIC PLANNING GUIDE

This form is a consolidation of the information listed on an air movement planning worksheet. It should be sent to your higher headquarters because movement planners at that level can estimate the number of aircraft needed for your unit move. A suggested format for a basic planning guide is illustrated below.

BASIC PLANNING GUIDE

UNIT AIRCRAFT UTILIZATION PLAN (MAC Form 551)

This form, shown on the facing page, identifies your equipment by aircraft load. It will allow you to plan a number of identical type-loads.

AIR LOADING TABLE

This is the final form to be used in your planning. Using all the other forms, you plan the loading of all your equipment and personnel onto the aircraft. This form will become the air

[illegible]

(Suggested Format)

1. UNIT TYPE PLAN (1) 2. UIC (1) 3. UIC (1) 4. DATE PREPARED (1) 5. PROJECT OFFICER (Name, grade and organization) (1) 6. TELEPHONE NO. (1) 7. MAC PLANNER (Name, grade and organization) (1) 8. PAUSE (1) 9. PAUSE (1)

NOTE 1. COMPLETE COLUMNS 4 THROUGH 11 AND ITEMS 8 THROUGH 12

TYPE AIRCRAFT TOTAL AIRCRAFT LOAD PLANNING (To be completed by ME PLANNER, See Note 1)

QUANTITY	ITEM	NOTE	LENGTH	WIDTH	HEIGHT	EMPTY WEIGHT	PLANNED WEIGHT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000
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NOTE 2. COMPLETE COLUMNS 13 THROUGH 15 AND ITEMS 13 THROUGH 15

PLANNING SUMMARY DATA

TYPE AIRCRAFT	PASSENGERS	AVG PAYLOAD	CGO MSNS	AVG PAYLOAD	OVERSIZE WEIGHT	OUTSIDE WEIGHT	BULK WEIGHT	TOTAL WEIGHT	BULK CARGO MOBILE LOAD
1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110
111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130
131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170
171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190
191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210
211	212	213	214	215	216	217	218	219	220
221	222	223	224	225	226	227	228	229	230
231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250
251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270
271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290
291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310
311	312	313	314	315	316	317	318	319	320
321	322	323	324						

AIR LOADING TABLE

Once you know the mission, you must plan to take what you will need to accomplish the mission. Using information given in chapter 5, load all your vehicles with as much unit equipment as possible. Be sure the load capacity of the vehicle is not exceeded; be positive that all cargo is secured in the cargo compartment. To insure accurate figures, measure and weigh the vehicles **after** they have been loaded. The vehicles will be weighed again before

they are loaded aboard the aircraft. Guidance for weighing and marking your vehicles is provided in chapter 5 of this manual, and in AR 220-10. When you must load and lash vehicles, read chapter 10 of FM 55-30.

Often, personnel responsible for movement of a unit will make a rough sketch, called a vehicle load card, of each vehicle to be loaded aboard an aircraft. Each sketch will include such information as load data for the vehicle; length and width of the vehicle; and, when the vehicle(s) will carry loads, the names and locations in the truck of the cargo to be placed in the cargo bed. This card can be a very simple locally-prepared sketch.

UNIT: _____

LOAD DATA: _____

NOMENCLATURE _____

LINE NUMBER _____

WEIGHT (EMPTY) _____

BUMPER NUMBER _____

FRONT AXLE _____

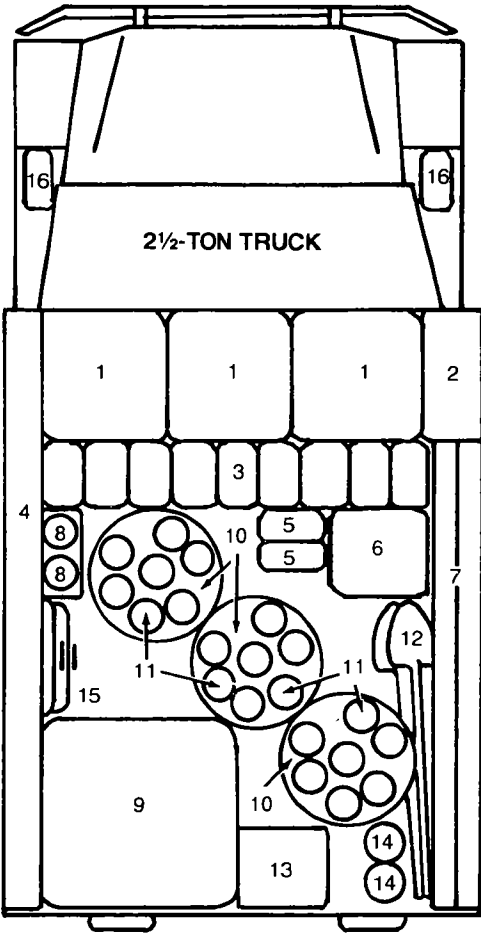
REAR AXLE _____

CG _____

TOTAL WEIGHT _____

CARGO:

1. M59 field ranges with cooking equipment and items from accessory outfit stored inside
2. Accessory outfit tool chest with some accessory outfit items
3. Insulated food containers
4. Tent poles
5. 5-gal water cans with taps for hand washing
6. Water-sterilizing bags (2)
7. Folding work tables (2)
8. Gasoline lanterns (2)
9. Kitchen tent in tent cover or burlap
10. 32-gal ash cans (6)
11. Immersion heater units (3) packed in ash can with sections of pipe
12. Pioneer tools for digging soakage pits and grease traps and for pitching tent
13. Tent pins
14. Fire extinguishers (2)
15. Ash can lids (2) for trash cans
16. 5-gal gasoline cans (2)



EXAMPLE OF A VEHICLE LOAD CARD

BASIC PLANNING GUIDE
(Suggested Format)

Using your unit TOE as a guide, start your Air Movement Planning Worksheet with the first element. When planning a tactical move, maintain as much unit integrity as is consistent with the principles of aircraft use. Fill in the weight and dimension data to include the cargo weight of the vehicles carrying cargo. Before you go on to anything else, complete the worksheet, because you will very rarely be able to load plan the aircraft in the same order in which the elements appear on the Air Movement Planning Worksheet.

The next step is to complete the Basic Planning Guide. This information is needed by your higher headquarters to give a picture of the overall air movement requirement. Using the data from your Air Movement Planning Worksheet, fill in the guide as illustrated. Note that this format uses consolidated data; do not list your personnel and vehicles by organizational element. List all the attachments or additions separately; it will assist your higher headquarters to identify all the units involved.

When all the preparatory work has been done, planning of the aircraft loads can proceed. Using the Unit Aircraft Utilization Plan (MAC Form 551), list in columns a and b all the **different**

BASIC PLANNING GUIDE				HEADQUARTERS CSC, 1 ST BN 77 TH INF (MECH) 7 TH ARMD. DIV.					OPERATION						DATE			
ORGANIZATION	PERSONNEL								VEHICLES, EQUIPMENT AND SUPPLIES								REMARKS	
	ASSAULT ECHELON				FOLLOWUP		TOTAL REAR ECH	TOTAL INEF- FEC- TIVES	TYPE	ASSAULT ECHELON				FOLLOWUP		REAR ECHELON		
	PARACHUTE AIRDROP		AIRLAND							AIRDROP		AIRLAND						
	TOTAL	WT	TOTAL	WT	TOTAL	WT				TOTAL	WT	TOTAL	WT	TOTAL	WT	TOTAL		WT
CSC			143	34,320					1/4 T TRK			12	30,984					
									1/4 T TRK			12	12,960					
									1/4 T TRK			8	29,264					
									(106MM)									
									5/4 T TRK			1	8,139					
									(M880)									
									5/4 T TRK			1	8090					
									(M561)									
									3/4 T TRK			1	2,760					
									2 1/2 T TRK			2	37,140					
									1 1/2 T TRK			2	9,340					
									M114A1			11	150,909					
									M113			1	19,173					
									577A1			1	23,547					
									M578			1	48,563					
									M106A1			4	81,512					
ATTACHMENTS																		
FO. TEAM			2	480					1/4 T TRK			1	2,548					
									1/4 T TRK			1	1080					

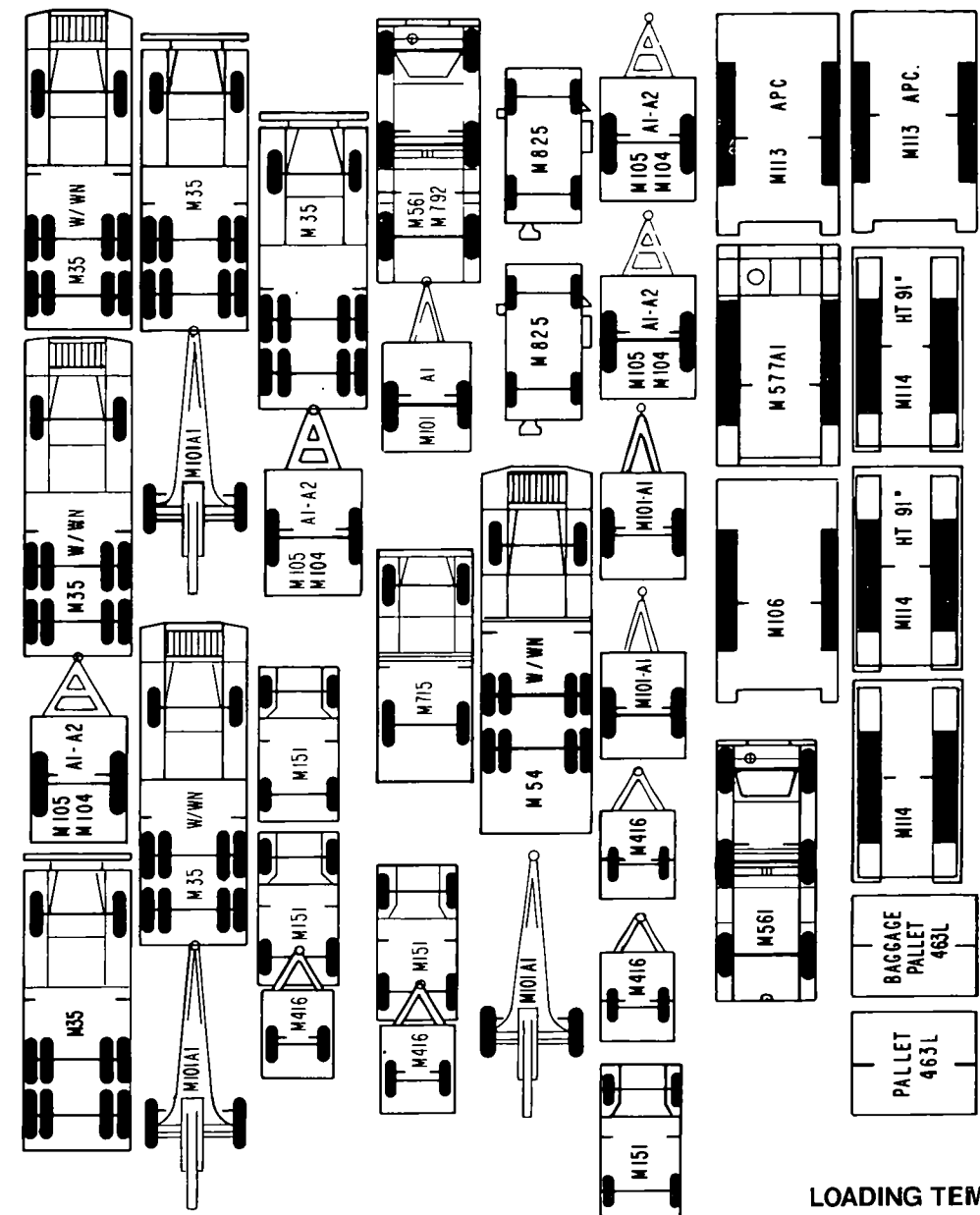
1. UNIT/TYPE PLAN (1) A CD. '77 INF (MECH)			2. UIC (1) WABCD		3. UTC (1)		4. DATE PREPARED (1)		5. PROJECT OFFICER (Name, grade and organization (1) 2LT T. BARNES ACD '77 INF			6. TELEPHONE NO. (1) (Include AUTOVON) XXX-2345			7. MAC PLANNER (Name, grade and organization) CM56 C. RUIS 436 ALCE			PAGE 1 OF 1 PAGES																											
SEE NOTE 1 - COMPLETE COLUMNS A THROUGH H AND ITEMS 8 THROUGH 32										TYPE AIRCRAFT/TOTAL AIRCRAFT/LOAD PLANNING (To be completed by MAC planner - See Note 3)																																			
QUAN- TITY	ITEM		SEE NOTE 2	LENGTH	WIDTH	HEIGHT	EMPTY WEIGHT	PLANNED WEIGHT	1-5																													QNTY TOTALS							
a	b		c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	ab	ac	ad	ae	af	ag	ah	ai	aj	ak	al	am	an	ao	ap	aq	ar	as
8	10	APC M113A1		191.5	99.6	84		20,526	2																													8							
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30		463L	CUBE (each)																																			30							
31		PALLET	CUBE (each)																																			31							
32		TROOPS	POUNDS (each)	SEATS AVAILABLE																																		32							
				SEATS USED.																																									
33	TOTAL TYPE LOADS (To be completed by MAC planner)									5																													33						
PLANNING SUMMARY DATA																																													
TYPE AIRCRAFT	PAX MSNS	AVG PAYLOAD	CGO MSNS	AVG PAYLOAD	42. OVERSIZE WEIGHT																																								
a	b	c	d	e																																									
34																																													
35					43. OUTSIZE WEIGHT																																								
36																																													
37					44. BULK WEIGHT																																								
38																																													
39					45. TTL WT (42 thru 44)																																								
40																																													
41	TOTAL				46 BULK CARGO MOBILE LOAD																																								
NOTES: 1. Completed by project officer. 2. Use these marks to indicate cited conditions. X = Oversized ✓ = Bulk Cargo O = Oversized							3. Mobile Load (Stacking)/Side-by-Side Planning (To be shown in aircraft load column - see sample)							A. Equip/items planned side-by-side (Use slash mark)							B. Like items to be stacked (Circle number)							C. Other items to be stacked (P = Primary, S = Items to be stacked on primary)																	
														2/							7							4P 3S																	

UTILIZATION PLAN

kinds of vehicles and equipment you are planning to airlift. Always list the **heaviest** weight for each vehicle type in your unit to insure that you do not go over the ACL. Then, fill in the dimensions from your Air Movement Planning Worksheets. If there is one vehicle that is a few inches larger than others of the same type because of some modification, make sure that you use a separate column for it. Note that the difference between “empty weight” and “planned weight” is the amount of cargo placed in those vehicles capable of carrying cargo.

Starting with column i, list all the vehicles, equipment, and personnel in the unit and in any attached units. Next, list your aircraft loads by vehicle type. You will want to get as many as possible of these aircraft loads exactly the same. If you have 10 M-113 Armored Personnel Carriers, for example, list them as 5 aircraft loads, and you do not have to worry about them again. Continue through your entire organization the same way until all the vehicles and personnel are assigned a type-load. After each type-load has been planned, make sure you subtract the vehicles and personnel. Insure that you do not exceed your given ACL and that you are using the aircraft as effectively as possible.

Here, you must list all hazardous cargo documentation requirements and all shoring requirements. When you have finished each type-load, use a copy machine to copy as many different aircraft loads as you need of each type-load.



LOADING TEMPLATE

1. UNIT ACD 1ST BN 77TH INF (MECH)		2. UNIT IDENTIFICATION CODE WABCD		3. TYPE PLAN TACTICAL		4. DATE		5. UNIT AIRCRAFT LOAD NO. 1 of 5					
6. MISSION NO. (//)		7. AIRCRAFT NO. (//)		8. AIRLIFT UNIT 436 MAW		9. DEPARTURE AIRFIELD/ETD		10. DESTINATION/ETA					
11. ACTUAL LOADOUT													
1/8" = 1 FOOT													
LOAD(//) SEQUENCE A	ITEM MODEL AND NOMENCLATURE/DESCRIPTION B	VEHICLE PACKAGE NO. C	SERIAL INCREMENT NUMBER D	REMARKS (Special handling, shoring, configuration, etc.) E	F. PLANNING DATA				G. ACTUAL DATA				FUSELAGE(//) STATION H
					LENGTH	WIDTH	HEIGHT	WEIGHT	HEIGHT	CUBE	WEIGHT	CG	
	CARR, PERS M113A1	A-10		PARKING & ROLLING SHORING	191.5	99.6	84	20,526					
				NEEDED 1387-2 FOR AMMO, BTRY FUEL									
	CARR, PERS M113A1	A-11		PARKING & ROLLING SHORING	191.5	99.6	84	20,526					
				NEEDED 1387-2 FOR AMMO, BTRY FUEL									
	TRK, 1 1/4 T M880	HQ3		1387-2 FOR BTRY, FUEL	218.5	79.8	73.5	7,595					
	TROOPS 6			240 LB. EACH				1,440					
TOTAL					601.5			50,087					
12. PAX			13. DATE APPROVED (//)		14. NAME, GRADE AND ORG OF APPROVING OFFICIAL (//)				15. SIGNATURE (//)				
MAX NO. AVAIL SEATS (//)		NO SEATS USED											

COMPLETED AIR LOADING TABLE

After you have made your copies, fill in the bumper numbers, weights, and dimensions of the vehicles on the front of the form. Fill in only the "Planning Data" columns. The "Actual Data" columns will be filled in when you actually move. Next, fill out the tactical elements for each aircraft load on the reverse of the MAC Form 342 (see below). As you add each element to the plan, go back to the Air Movement Planning Worksheet and check it off. Remember, **do not** put in names and SSANs at this time. They will be added only after your unit has been alerted for a move.

When all data has been entered on appropriate MAC forms, contact your affiliated ALCE to go over the entries with you. The Air Force must approve your loads before you load any aircraft. Your Air Force ALCE representative can authorize your loads and sign your air loading documents.

MANIFEST						
16. MISSION NO.		17. AIRCRAFT NO.		18. DEPARTURE AIRFIELD		19. DESTINATION
LINE NO. A	GRADE B	NAME AND SSAN C	D. CHECKED BAGGAGE		PAX WEIGHT E	REMARKS F
			PIECES	WEIGHT		
		DRIVER & ASST A-10			2	1ST RFL PLT
		DRIVER & ASST A-11			2	1ST RFL PLT
		DRIVER & ASST HQ3			2	MAINT SEC
					6	TOTAL
TOTAL						TOTAL WEIGHT PASSENGERS AND ALL BAGGAGE
20. I CERTIFY THAT AN ANTIHIJACKING INSPECTION HAS BEEN CONDUCTED ON ALL PERSONNEL FOR WHOM I HAVE BEEN DESIGNATED TROOP COMMANDER. I FURTHER CERTIFY THAT NO UNAUTHORIZED WEAPONS OR EXPLOSIVE DEVICES ARE IN THEIR POSSESSION.						
DATE		PRINTED NAME AND GRADE			SIGNATURE	

MANIFEST
(Reverse of MAC Form 342)

EXAMPLE

You are the newly assigned movement officer for "A" Company, 1/77 Inf (Mech). Your company movement plans are far out of date, and your company commander has told you to update them as soon as possible.

First, you read your unit contingency plans to find out if there are any special mission requirements. You find they call for you to take all your equipment on an overseas tactical move. Next, you check your company TOE and property book to determine what you are authorized and what you have on hand. You discover your company has received the new TOW missile carriers, and exchanged an M715 1¼-ton truck for an M561. No vehicle load cards have been made up for these new vehicles, but all the load cards for the other vehicles seem to be in order. After checking the published weights in TB 55-46-1, you load the new vehicles with their combat load and weigh them. The new weights are noted and load cards for the vehicles are made.

Now you are ready to enter movement data on a movement planning work sheet. Remember, this worksheet is something you must make up for your planning. Any grid-type paper will do; an illustration of the format was shown on page 6-3. In this example, your work would look as shown on the worksheets below.

PLANNING WORK SHEET

AIR MOVEMENT PLANNING WORK SHEET											
UNIT	PERSONNEL				REMARKS	EQUIPMENT - VEHICLES					
	Str	Chalk No.				Type	ID No.	Equipment	Length	Width	Height
MORT SEC					CARR, MORT	M125A1	A48	B1 M4	191.5	100	84.8
AT SEC	8				CARR, TOW	M113A1	A49	TOW, M113	191.5	100	84.5
					CARR, TOW	M113A1	A50	TOW, M113	191.5	100	84.5
ATTACHMENTS											
AMB PT HQ	3				TRK, 1/4 T	M151A2	01		131.5	64	52.5
					TLR, 1/4 T	M416	02		108.5	61.5	44
AMB SEC	40				TRK, AMB, 1/4 T	M886	07		223.8	91.3	103.3
					TRK, AMB, 1/4 T	M886	08		223.8	91.3	103.3
					TRK, AMB, 1/4 T	M886	09		223.8	91.3	103.3
					TRK, AMB, 1/4 T	M886	10		223.8	91.3	103.3
F.O. TEAM	2				TRK, 1/4 T	M151A2	HQ 32		131.5	64	52.5
					TLR, 1/4 T	M416	HQ 33		108.5	61.5	44

AIR MOVEMENT PLANNING WORK SHEET											
UNIT	PERSONNEL				REMARKS	EQUIPMENT - VEHICLES					
	Str	Chalk No.				Type	ID No.	Equipment	Length	Width	Height We
2 ND PLT											
PLT HQ	5				CARR, PERS	M113A1	A21		191.5	99.6	84 20.2
1 ST SQD	11				CARR, PERS	M113A1	A22		191.5	99.6	84 20.2
2 ND SQD	11				CARR, PERS	M113A1	A23		191.5	99.6	84 20.2
3 RD SQD	11				CARR, PERS	M113A1	A24		191.5	99.6	84 20.2
3 RD PLT											
PLT HQ	5				CARR, PERS	M113A1	A31		191.5	99.6	84 20.2
1 ST SQD	11				CARR, PERS	M113A1	A32		191.5	99.6	84 20.2
2 ND SQD	11				CARR, PERS	M113A1	A33		191.5	99.6	84 20.2
3 RD SQD	11				CARR, PERS	M113A1	A34		191.5	99.6	84 20.2
WPNS PLT											
	3				TRK 1/1				131.5	1	

AIR MOVEMENT PLANNING WORK SHEET											
UNIT	PERSONNEL				REMARKS	EQUIPMENT - VEHICLES					
	Str	Chalk No.				Type	ID No.	Equipment	Length	Width	Height Weig
CO HQ	10				CARR, PERS	M113A1	A1		191.5	99.6	84 20.2
					CARR, PERS	M113A1	A2		191.5	99.6	84 20.2
					1/4 T TRK	M161A2	A3		131.5	64	62.5 20.5
					1/4 T TLR	M416	A4		108.5	61.5	44 104
					2 1/2 T TRK	M35A2	A5		278.5	95.4	80.8 178
					1 1/2 T TLR	M105A2	A6		166	83	55 41.1
MAINT SEC	11				TRK 2 1/2 T	M35A2	A7		278.5	95.4	80.8 185.6
					TLR 1 1/2 T	M105A2	A8		278.5	83	55 62.10
					TRK 1 1/4 T	M561	A9		231.1	95.3	67.5 178.6
					VCR	M578	A10		253.5	124	115 49.1
1 ST RT											

Begin with the first tactical element in your unit TO&E. Don't worry about the order in which they will go into the aircraft at this time. More important, make sure you have included every soldier and every piece of equipment in your unit, listing them by the smallest tactical element you need to control. When you have finished listing all your vehicles and personnel, check with your commander or operations officer for any special mission requirements.

Mission requirements are a vital part of air movement planning. Nothing will save the perfectly planned air movement if you discover your personnel have arrived to carry out the wrong mission. As the air movements officer, you must be alert to changes in contingency plans, or new commanders with a different approach to the mission. Any changes must be included in your plan.

Your company commander has told you that he wants to ride on the first aircraft with his vehicle, A-1, and that the company XO, with his vehicle, A-3, will ride in the last aircraft. Since the company will be responsible for its own security when it arrives, the rifle platoons will have to have movement priority. There will be an FO team and a MED detachment attached to your company for the move.

Next, you should contact the battalion or division movements officer to determine the type of aircraft you will receive and what their limitations are. The battalion movements officer has learned from the affiliated ALCE that you will receive C-141 aircraft with a critical leg ACL of 55,000 pounds. Also, the C-141 floor tread-way limitations restrict your M113-type vehicles to between fuselage stations 678 and 998. This means you will have to plan your loads very carefully, since the aircraft will be very close to its critical CG limits.

A basic planning guide is the next effort you must make (see page 6-4 for suggested format). If you have already worked up such a guide, it won't require changes unless there are major equipment changes or attachments that affect the airload total. You will have to total the weights of each vehicle type to insure the total weight is not underestimated. Multiply the **heaviest** vehicle of each type by the total number of vehicles (see example). It is always better to overestimate your weights, as this is usually the most critical planning factor in air movement. The guide, once completed, will assist your higher headquarters to program aircraft for deployment.

Next, you fill out the utilization plan, MAC Form 551. Fill in the quantity and type of each of your vehicles in columns a and b. They do not have to be in any special order, although we have listed the oversized vehicle first just to get it out of the way. Although the dimensions should not vary between individual vehicles of each type, the weights often will. List the dimensions

1. UNIT/TYPE PLAN (I) ACo 1st INF (MECH)			2. UIC (I) WABCD		3. UTC (I)		4. DATE PREPARED (I)		5. PROJECT OFFICER (No) 2LT T. BARNES								
SEE NOTE 1 - COMPLETE COLUMNS A THROUGH H AND ITEMS 8 THROUGH 32																	
QUAN- TITY	ITEM		SEE NOTE 2	LENGTH	WIDTH	HEIGHT	EMPTY WEIGHT	PLANNED WEIGHT									
a	b		c	d	e	f	g	h	i	j	k	l	m	n	o		
8	1	VCR M578		253.5	124	115		49,320									
9	15	APC M113A1		191.5	99.6	84		20,526									
10	2	APC M113A1 W/TOW		191.5	100	84.5		19,900									
11	3	MORT, CARR M125		191.5	100	84.5		20,395									
12	2	TRK, 2 1/2 T M35A2 W/T		278.5	95.4	80.8	13,570	17,845									
13	2	TLR, 1 1/2 T M105A2		166	83	55	2,670	4,170									
14	5	TRK, 1/4 T M151A2		131.6	64	52.5		2,595									
15	5	TLR, M416		108.5	61.5	44	580	1,080									
16	4	TRK, ANB, 1 1/4 T M886		223.8	91.3	103.3		6,150									
17	1	TRK, 1 1/4 T M561		231.1	85.3	67.5		7,860									
18																	
19																	
20																	
21																	
22																	
23																	
24																	
25																	
26																	
27																	
28																	
29																	
30		463L CUBE (each)															
31		PALLET CUBE (each)															
32	204	TROOPS		POUNDS (each) 240		SEATS AVAILABLE SEATS USED											
33	TOTAL TYPE LOADS (To be completed by commander)																
PLANNING SUMMARY DATA																	
	TYPE AIRCRAFT a	PAX MSNS b	AVG PAYLOAD c	CGO MSNS d	AVG PAYLOAD e	42. OVERSIZE WEIGHT		47 TOTAL CARGO WEIGHT i j k l m n o									
34						43. OUTSIDE WEIGHT											
35						44. BULK WEIGHT											
36						45. TTL WT (42 thru 44)											
37																	
38																	
39																	
40																	
41	TOTAL					46 BULK CARGO MOBILE LOAD		NOTES: 1 Completed by project officer. 2 Use these m indicate cite X = Outsized O = Oversi									

UTILIZATION PLAN

and weights of each type, using the **heaviest** vehicle of that type in your unit. An airplane can always fly with less weight, but almost never with more weight than planned.

Before making up your type-loads, eliminate any oversized or overweight vehicles that will not fit in the C-141. You have been told that a C-5 will pick up all the battalion's outsized equipment in one load, so you will not have to plan an aircraft load for it. Then, find your most common vehicles, and put as many into the aircraft as possible. As the M113 is the most common vehicle, multiply its weight until you come to the aircraft ACL.

You have been given an ACL of 55,000 pounds and your heaviest M113 is 20,526 pounds. Now you know you can get 2 of them in a C-141, but 3 would be too heavy. Remembering the restrictions on the C-141 and your commander's priorities, you now use

templates as shown on page 6-12 and place the vehicles in the aircraft. Then, count all the seats remaining and write the number at the bottom of the column. An M113 is too wide to allow anyone to sit alongside it, so remember to exclude those seats when counting up your total available. Of the 70 seats in a C-141, you find there are only 30 available after the vehicles are aboard.

Since you have 15 M113s that are essentially identical, it would seem that you could have as many as 7 type-loads immediately. Continue to plan your prime movers the same way until you have a type-load for all of them.

Now, go back and fill in with the lighter vehicles and cargo until you have the aircraft loaded to capacity. Although the TOW carrier, the M113, and the M125 mortar carriers are similar in size and appearance, they cannot automatically be considered the same vehicle type. In general, if similar vehicles are significantly different in weight, you may want to consider them as different types of vehicles for load planning purposes.

6-18

[illegible]

You will need a total of 11 C-141 sorties, plus the C-5 for your M578, to move the company. You will have more seats available on the aircraft than you will need to move the company, so the number of seats used is decided primarily for load-balancing reasons and to get as many identical type-loads as possible. A qualified load planner can type-load your entire unit in less than 15 minutes using this form; it should not take you too much longer than that.

When you have finished your type-load planning, you should have your affiliated ALCE approve it before you start on your Air Loading Tables. This will help you avoid problems later if you find something wrong. It is not necessary to make up your Air Loading Tables immediately; in fact, some units do not make them up until alerted for movement, relying upon the MAC Form 551 as their air movement plan. This is not generally recommended, especially if your unit is on a short-lead time contingency plan. You will need every second you can get to move out, and making up an air movement plan at the last minute would be an unnecessary delay.

When you have the MAC Form 551 approved, you can complete your Air Loading Tables. Access to a newer copy machine that will copy on both sides of the paper allows you to make one, instead of two, Air Loading Tables for each type-load. It is important to copy the back of the form, because you will need to list the tactical element in each aircraft load. If you do not have access to that type of copy machine, you will have to copy and fill out each form individually.

Remembering your commander's guidance, you begin to plan the first chalk. You can use one of the seven identical type-loads as your first chalk, since the commander's vehicle is an M113. If you have completed your MAC Form 551 correctly, the first chalk you select should meet your commander's guidance. You know the XO's vehicle is a ¼-ton and the rifle platoons have priority, so you use the type-load with the ¼-ton and mortar carriers as your last chalk. Put the bumper number on the vehicles you want to take in column C, and fill the Planning Data column (F), with the weights and dimensions of the vehicles as you measured and weighed them. The Actual Data column will be used for the final weigh-in just before you load the aircraft on your actual move.

MANIFEST						
16. MISSION NO.		17. AIRCRAFT NO.		18. DEPARTURE AIRFIELD		19. DESTINATION
LINE NO. A	GRADE B	NAME AND SSAN C	D. CHECKED BAGGAGE		PAX WEIGHT E	REMARKS F
			PIECES	WEIGHT		
		COMPANY CDR + DVR (A-1)			2	HQ SEC
		DVR + ASS'T (A-11)			2	1ST RFL PLT
		F.O. + DVR (HQ 32)			2	F.O. TEAM
		CO HQ			2	
		1ST RFL PLT HQ			3	
		1ST RFL PLT, 1ST SQD			7	
					18	TOTAL

COMPLETED MANIFEST
(Reverse of MAC Form 342)

List the crew members of each vehicle and their section on the back of the form. When you list the passengers below the vehicle crews, further remarks are unnecessary, unless you wish to identify something not otherwise obvious.

When you have completed the first chalk, go back to your Air Movement Planning Work sheet and mark off those you just "loaded." It is important to keep a very close control over the elements as you prepare this plan. You do not want to leave any of your personnel or equipment behind. As shown above, mark off the number of personnel and chalk number of each element as you plan them. Also, put the chalk number of each vehicle in the column under the type of aircraft you are using.

Upon completion of each plan, add up all personnel to insure that all are included. Then, check to insure that you have the "Remarks" column filled out on each of your Air Loading Tables. You should have all shoring and hazardous cargo requirements listed (see DD Form 1387-2 and TM 38-250).

AIR MOVEMENT PLANNING WORK SHEET															
UNIT	PERSONNEL				REMARKS	EQUIPMENT - VEHICLES							AIRCRAFT		
	Str	Chalk No.				Type	ID No.	Equipment	Length	Width	Height	Weight	Cargo	C-130	C-141
CO HQ	10				CARR, PERS	M113A1	A1		191.5	99.6	84	20,250			
					CARR, PERS	M113A1	A2		191.5	99.6	84	20,526			
					1/4T TRK	M151A2	A3		131.5	64	52.5	2,595			
					1/4T TLR	M416	A4		108.5	61.5	44	1,080	500		
					2 1/2T TRK	M35A2	A5		278.5	95.4	80.8	17,845	3,705		
					1 1/2T TLR	M105A2	A6		166	83	55	4,170	1,500		
MAINT SEC	11				2 1/2T TRK	M35A2	A7		278.5	95.4	80.8	18,550	4,650		
					1 1/2T TLR	M105A2	A8		278.5	83	55	6,210	3,540		
					1 1/4T TRK	M561	A9		231.1	85.3	67.5	7,860			
					VCR	M578	A10		253.5	124	115	49,320			
1ST PLT															
PLT HQ	5				CARR, PERS	M113A1	A11		191.5	99.6	84	20,245			
1ST SQD	11				CARR, PERS	M113A1	A12		191.5	99.6	84	20,200			
2ND SQD	11				CARR, PERS	M113A1	A13		191.5	99.6	84	20,200			
3RD SQD	11				CARR, PERS	M113A1	A14		191.5	99.6	84	20,200			

DD-1387-2

COMPLETED AIR MOVEMENT PLANNING

ITEM NOMENCLATURE		NET QUANTITY PER PACKAGE		TRANSPORTATION CONTROL NO.	
		CONSIGNMENT GROSS WEIGHT		DESTINATION	
SUPPLEMENTAL INFORMATION				LOAD STORAGE/GROUP	
				FLASH POINT	
This is to certify that the above named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the Dept of Transportation. THIS IS A MILITARY SHIPMENT! (Complete applicable blocks below)					
This shipment is within the limitations prescribed for PASSENGER AIRCRAFT/CARGO-ONLY AIRCRAFT (Delete nonapplicable aircraft)			ATA/IATA/IMCO REGULATIONS		
AFR 71-4, TM 38-250, NAVSUPPUB 505, MCO P403-19, LAM 4145 3, Paragraph _____			49 cfr		PARAGRAPH 173.7 (a)
DOD 4500.32R (MILSTAMP)			EXEMPTION DOT-E 7573		
ADDRESS OF SHIPPER			TYPED NAME, SIGNATURE AND DATE		
DD FORM 1 MAY 79 1387-2 PREVIOUS EDITION IS OBSOLETE. SPECIAL HANDLING DATA/CERTIFICATION					

Now that you've finished your air movement plan, have your affiliated ALCE and your battalion or division movements officer check it over. Then, brief your company, as it is important that everyone know exactly where he should go and what he should do when the alert order comes. It would probably be a good idea to have a few practice alerts just to make sure everyone knows his job. When the alert really comes, whether a test or an actual deployment, there will be no time to tell everyone what to do.

MANIFESTING

Preparation of the air manifest is the last step before an air movement. Federal law requires a manifest for all air movement, military as well as civilian, so you will have to do a good job. Although some installations use computer-generated manifests for their contingency plan moves, these are not yet in widespread use. So to be on the safe side, you should know how to prepare the manifest manually.

If you have completed your unit movement plan, part of your manifesting task is already done. The Air Loading Table is the same form you will use to manifest your flight. If you can copy your Air Loading Tables in sufficient copies, you can use them as your manifest. However, you will have to fill in the rest of the data first. As you will have to list your personnel by name and SSAN, the copy machine will also have to copy both sides of this form.

Using the DD Form 2130, 2131, or 2132, or MAC Form 342 or 559, complete all the blocks as listed below:

Block 1 Give full nomenclature for your unit.

Block 2 Five-digit UIC.

Block 3 Type of plan: Tactical or Administrative.

Block 4 Actual flight date only (if not known leave blank).

Block 5 Chalk number of this load and total number of chawks.

Block 6 Filled out by Air Force.

Block 7 Filled out by Air Force.

Block 8 Filled out by Air Force.

Block 9 Use “in-the-clear” address and **actual** date.

Block 10 Use “in-the-clear” address and **actual** date.

Block 11A List vehicles and cargo in sequence as actually loaded.

Block 11B Use official Army vehicle nomenclature.

Block 11C Bumper number.

Block 11D Serial or ID number, container number if there is no bumper number.

Block 11E Hazardous cargo annotation from the DD Form 1387-2; shoring requirements.

Block 11F Use TB 55-46-1 data unless better data are available.

Block 11G Use **actual** data. Vehicles and cargo must be weighed and measured.

Block 11H Filled out by Air Force after cargo is loaded.

Block 12 Filled out by Air Force.

Block 13 Filled out on the date approved by MAC.

Block 14 Usually the MAC ALCE representative, but must be a loadmaster authorized to approve the load.

Reverse side:

Blocks 16-19 Repeat from the front of the form.

Passenger Section: Fill in as indicated on the form. List all vehicle crews first, as the vehicles are listed on the front of the form. If actual weights are not known, a standard weight for each soldier may be listed.

Block 20 The troop commander must conduct the anti-hijacking search before soldiers board the aircraft.

Distribution of the completed manifest will be made in the following manner: additional copies may be required for intermediate airfields prior to your arrival.

For CONUS moves: 7 copies total

Copy 1 Retained by unit

Copy 2 Departure Airfield Control Group

Copy 3 ALCE

Copy 4 Load Team

Copy 5 Loadmaster

Copy 6 Arrival ALCE

Copy 7 Arrival Airfield Control Group.

For overseas moves: 15 copies total

Copies 1-7 Same as above

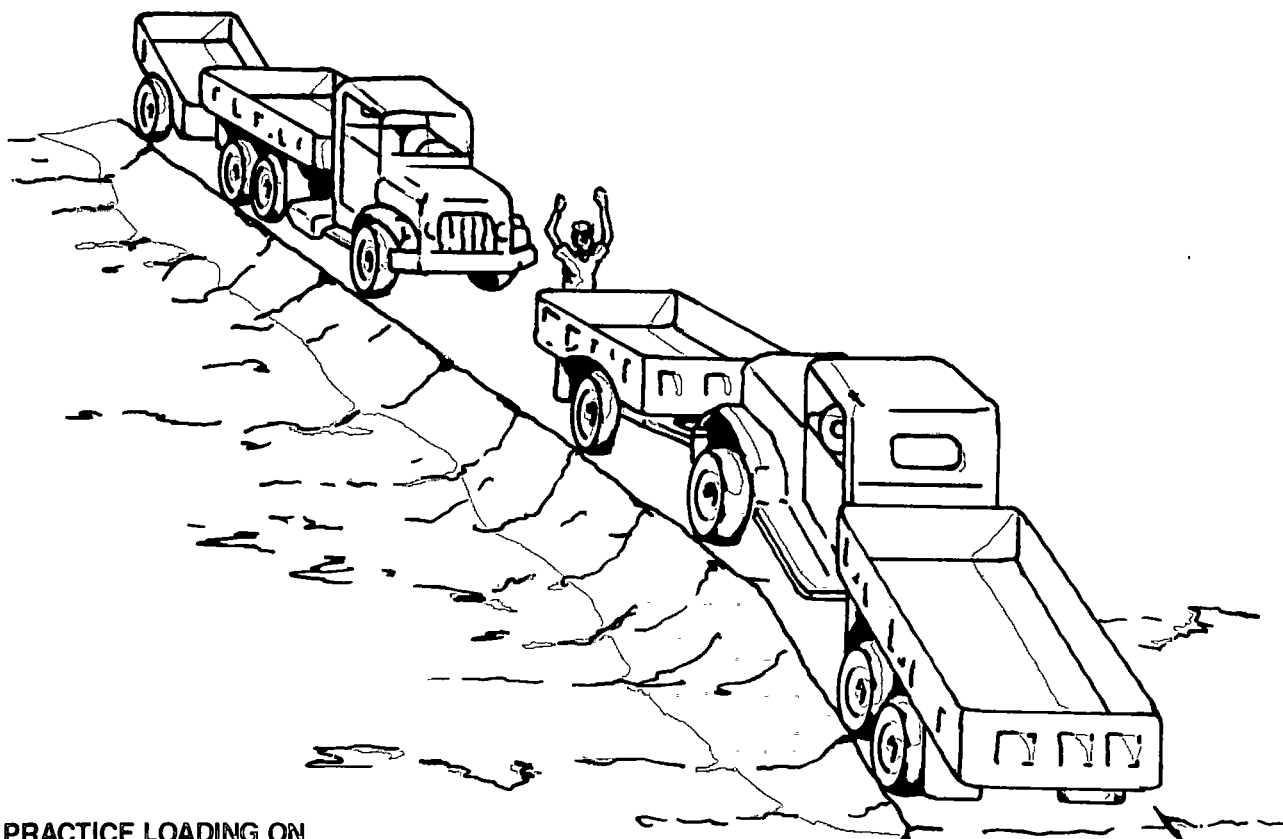
Copies 8-15 Customs official at arrival and departure airfields.

Before you make up the manifest, check with your affiliated ALCE. Since the manifest must be absolutely accurate, all last-minute changes must be reflected on it. Practically speaking, it will often be easier to change bumper numbers on vehicles than to change their numbers on a manifest in case of any last-minute substitution for broken-down vehicles.

TEST LOADING

The last step before you can say your movement plan is ready for use is to test it. It is one thing to draw small outlines on a piece of paper, and entirely another to actually load a vehicle onto an airplane. Although aircraft can be requested through your affiliated ALCE or DTO, you may have to use an aircraft mock-up like the one shown on page 6-26 for most of your testing. If your installation does not have an aircraft mock-up, you can simulate one by drawing a chalk outline on a section of hardstand.

The use of a mock-up will provide your unit drivers with valuable training in maneuvering in tight places. It also gives you an idea of how the movement plan really works. If used in conjunction with other training in maneuvering in tight places. It also gives you an idea of how the movement plan really works. If used in conjunction with other training, the mock-up can provide a valuable rehearsal for an actual alert. A test load-out can give you an idea of how long it will take to load your unit equipment and prepare your personnel for the movement. The more you rehearse an operation as complex as an air movement, the better it will go when the actual alert is given.



**PRACTICE LOADING ON
AN AIRCRAFT MOCKUP**

SUMMARY

Air movement planning is a difficult and exacting task. To do it well, you have to know the characteristics of different aircraft and how to load and balance them. Also, knowing how to weigh and balance your vehicles, being able to determine how much restraint and shoring to use, and knowing how to apply it are important. You will have to be very familiar with your unit contingency plans, and know your entire unit TOE and the characteristics of all your vehicles.

Do not forget your air movement plan once you have finished it. You must update your plan frequently, perhaps as often as monthly, to insure that your plan will work when you need it. Aircraft capabilities and unit equipment assignments change almost daily; you should be aware of this and change your plan to reflect the latest information. As is true of any complex operation, your plan is not complete until you practice it. Only then will you be sure your plan will work when you need it.

APPENDIX A

REFERENCES

Army Regulations (AR)

59-106/AFR 76-7	<i>Operation of Air Force Air Terminals</i>
220-10	<i>Preparation for Oversea Movement of Units (POM)</i>
310-25	<i>Dictionary of United States Army Terms</i>
310-50	<i>Authorized Abbreviations and Brevity Codes</i>

Field Manuals (FM)

55-12	<i>Movement of Army Units in Air Force Aircraft</i>
55-13	<i>Air Transport of Supplies and Equipment: Standard Loads in the C-5 Air Force Aircraft</i>
55-15	<i>Transportation Reference Data</i>
55-30	<i>Army Motor Transport Units and Operations</i>

Technical Manuals (TM)

38-250	<i>Packaging and Materials Handling: Preparation of Hazardous Materials for Air Shipment.</i>
55-450-10/1	<i>Air Transport of Supplies and Equipment: Standard Loads in the Air Force C-130E Aircraft</i>
55-450-10/2	<i>Air Transport of Supplies and Equipment: Standard Loads in the Air Force C-141A Aircraft</i>

Technical Bulletins (TB)

55-46-1	<i>Standard Characteristics (Dimensions, Weight and Cube) for Transportability of Military Vehicles and Other Outsize/Overweight Equipment</i>
GTA 55-7-2	<i>Air Movement Planning Guide</i>

Sources for obtaining MAC forms needed in planning the movement of Army materiel and equipment in Air Force aircraft:

Military Air Wings (MAW)

C-5 Aircraft

436 MAW, Dover AFB, DE 19901
60 MAW, Travis AFB, CA 94535

C-141 Aircraft

437 MAW, Charleston AFB, SC 29404
438 MAW, McGuire AFB, NJ 08641
60 MAW, Travis AFB, CA 94535
62 MAW, McChord AFB, WA 98438
63 MAW, Norton AFB, CA 92409

Tactical Air Wings (TAW)

C-130 Aircraft

314 TAW, Little Rock, AR 72076
317 TAW, Pope AFB, NC 28308
374 TAW, Clark AFB, PI APO San Francisco 96274
435 TAW, Rhein Main, Germany, APO New York 09057
463 TAW, Dyess AFB, TX 79607

Military Airlift Command

Attn: DAPD, Scott AFB, IL 62225

For emergency requisitions, call AUTOVON 638-4323

APPENDIX B

GLOSSARY, AIR FORCE TERMS

This glossary consists of selected terms and abbreviations from MAC Regulation 76-1. It will provide Army personnel, who may be unfamiliar with Air Force terms, a reference for common understanding in the mission of preparing Army loads for movement in Air Force aircraft.

Abort: Turn back from an airlift mission before the next scheduled destination is reached, for reasons other than enemy action. This may occur after an aircraft is airborne, or on the ground before takeoff.

Accepted Cargo: Cargo whose packaging and documentation have been verified with respect to shipment information required by applicable DOD regulations, and cargo which is in one of the processing phases necessary to prepare it for onward movement.

Accompanied Baggage: That personal and public property carried or accompanied by a passenger and not documented as cargo.

ADP: Automatic data processing.

Aerial Port: An airfield which has been designated for the sustained air movement of traffic and to serve as an authorized port for entrance or departure to or from the country in which located.

Aerial Port of Debarkation (APOD): A station which serves as an authorized port to process and clear aircraft (scheduled, tactical, and ferried) and traffic for entrance to the country in which located.

Aerial Port of Embarkation (APOE): A station which serves as an authorized port to process and clear aircraft (scheduled, tactical and ferried) and traffic for departure from the country in which located.

Agency for Airlift: See Single Manager for Airlift Service.

Airlift Clearance Authority (ACA): The agency controlling cargo flow into an aerial port under provisions of MILSTAMP, DOD 4500.32R.

Airlift Contract: A contract between the Government and an air carrier to provide transportation for DOD-sponsored traffic.

Airlift Control Center (AF)(ACC): An operations center where detailed planning, coordinating, and tasking for tactical airlift operations are accomplished. This is the focal point for communications and the source of control and direction for the tactical airlift forces.

Airlift Control Element (ALCE): A functional airlift organization (provisional) established to provide operational control and support to air elements at an air facility. Normally, it includes an operations function, such as movement control and communications, a support function which relates to the air facility itself, and a liaison with appropriate airborne or other air units. The ALCE is utilized to support and control exercise/contingency operations on both a planned and a "no-notice" basis.

Airlift Mission: A mission operated to meet an airlift requirement.

Airlift Operations: The operation of aircraft for the purpose of airlifting passengers, cargo, and mail for the DOD.

Airlift Requirement: The total number of passengers and/or tonnage of cargo/mail forecast to be airlifted to or from an area during a specified period of time.

Airlift Shippers Guide/Channel Sequence Listing: A user-oriented publication that will be published semiannually and will incorporate the information currently in the MAC Channel Sequence Listing. The guide identifies all MAC channels and the day of operation of the fixed cargo schedule over inter-theater channels, and contains a cargo routing guide.

Air Line of Communication: The air routes which connect an operating military force with a base of operations, and along which supplies and reinforcements move.

Air Movement Designator (AMD): A combination of letters and numbers assigned in accordance with established codes to identify the originating and destination station, priority, type of travel, and sponsoring department in whose interest the traffic is being moved.

Air Terminal: A facility on an airfield which functions as an air transportation hub, and which monitors the loading and unloading of aircraft and the intransit processing of traffic. The airfield may or may not be designated an aerial port.

Air Terminal Manager: The individual responsible to the organizational commander for the overall management, control, inspection, and technical supervision of air terminal operation activities.

Air Terminal Operations Center (ATOC): Formerly traffic control section. The air terminal work center which exercises operational control over other terminal work centers by coordinating their efforts in loading and unloading traffic, and in providing fleet service support to aircraft.

Air Traffic Coordinating Officer (ATCO): Representatives of the services located at aerial ports of embarkation for the purpose of coordinating the flow of all air traffic routed into the MAC system. Services apply varying terms/titles to their representatives such as MATCO, APLO, etc.

Allowable Cabin Load (ACL): The amount of cargo, mail, and/or passengers, determined by weight and distance to be flown, which may be transported by a specific aircraft.

APOD Processing Time: Begins at aircraft arrival and terminates when cargo is ready for movement.

APOE Processing Time: Begins at truck/aircraft (LOGAIR/QUICKTRANS) arrival at the CONUS APOE and terminates when cargo is processed for movement and is entered into the port management on-hand level.

Authorized Ground Time: The ground time authorized an aircraft on a mission as published in the MAC cargo and passenger schedules, mission setup message (AM-4), or OPLAN/OPORD. See ground time.

Average Age: Concerns cargo on hand at an aerial port. Reflects the arithmetic mean of the elapsed time between cargo receipt time and a particular point in time, such as 2400Z. Reflects average based on shipments on hand.

Average Port Hold Time: Concerns cargo that has departed an aerial port. Reflects the arithmetic mean of the elapsed time between cargo receipt and the actual time of movement. Reflects average based on shipments moved.

Average Processing Time: Concerns cargo that has departed an aerial port. Reflects the arithmetic mean of the elapsed time between cargo receipt and the time cargo is entered into the on-hand level. Reflects average based on shipments processed.

Backup Aircraft: An aircraft ready, available, and unassigned, which may be substituted for the assigned aircraft for a specific mission.

Baggage Allowance: The maximum baggage weight, as specified in the travel orders, that may be carried by the passenger.

Base Consumption: Cargo which has an ultimate consignee code of the local base supply activity, or any unit which is supported by the local base supply activity.

Block Time: Time when aircraft brakes are released on initial taxi and that time when the aircraft is parked upon arrival.

Blue Bark: US military personnel, US citizen civilian employees of the DOD, and the dependents of both categories when travel is a result of the death of an immediate family member. It also applies to escorts for dependents of military members traveling under competent orders issued pursuant to Joint Travel Regulations, paragraph 6400.

Border Clearance: Entry and exit clearances and inspections required to comply with agriculture, customs, immigration, and immunization directives.

Borrowed Aircraft: Aircraft on loan from another command, or a nonindustrial fund unit of the single manager.

Cargo: All matter consigned for shipment by aircraft including remains of deceased personnel and courier material, but excepting mail, passengers, and patients and their accompanied baggage.

Cargo Awaiting Airlift: Begins when cargo is movement-ready and terminates when the aircraft departs the CONUS APOE.

Cargo Awaiting Surface Lift: Elapsed time between when cargo is movement-ready and when custody is transferred.

Cargo Configured Aircraft: Aircraft employed principally for transportation of cargo and mail.

Cargo Density: Weight of a package expressed in terms of pounds each cubic foot.

Cargo Intransit Time: Elapsed time between when cargo is lifted from APOE to arrival at the final APOD.

Cargo Processing Phases: All actions related to the processing of cargo and associated documentation into a unit configuration that is acceptable for onward movement.

Cargo Routing Directive: Concepts and procedures that are published in the MACAF Operations Policy

or Channel Traffic Movement Plan which state transshipment policy and identify authorized transshipment points.

Carrel: A specially designed facility that provides a suitable learning environment for individual instruction. Usually equipped with hardware to support a multimedia approach to instruction.

Categories of Airlift — International:

(1) Category A — Transportation of passengers or cargo in less than planeload lots on a carrier's regularly-scheduled commercial flight.

(2) Category B — Transportation of passengers and/or cargo in full planeload lots on other than carrier's regularly-scheduled commercial flight.

(3) Category Y — (Blocked Space) Transportation of passengers in blocks of not less than 20 on a carrier's regularly-scheduled commercial service round trip, at round-trip Category "B" passenger rates. Under JTR, reimburses MAC at the common user rate established by AFR 76-11.

(4) Category Z — Individually-ticketed passenger service procured by TR by military agencies for their own use on scheduled commercial service. Payment in accordance with carrier's filed tariff.

Center of Balance: CB (Formerly CG).

Central Data Collection Point (CDCP): Air terminals designated to receive and consolidate transportation data from other specified units for retransmission to higher headquarters. These units are equipped with punch card accounting machines (PCAM). See RTDPC.

Channel: Two geographical points between which common user airlift service may be provided on a scheduled basis. A channel does not represent the actual aircraft routing, although the two may be the same. Channels are established by Headquarters USAF.

Channel Extension: Traffic originating and/or terminating in the proximity of a channel location. Authorized by Headquarters MAC to onload/offload traffic as required.

Channel Objective Time: An objective for the cargo intransit time developed for each CONUS to overseas channel. Although the objective for some channels may exceed the intransit time standards, the objectives must be designed to insure the overall average for the UMMIPS logistics area is met.

Channel Traffic: The movement of personnel and cargo over routes established by MAC, using either military or commercial airlift.

Checked Baggage: That baggage accepted and checked for a flight at the time a passenger is processed. After being checked, baggage normally is not accessible to the passenger during flight.

Chemical Munitions: Those bombs, projectiles, grenades, or the like containing a chemical agent. Such agents include war gases and incendiaries, but exclude riot control agents.

Civil Reserve Air Fleet (CRAF): Civil air carriers of US registry who contractually commit themselves to provide personnel, services, and aircraft to support MAC under stated emergency conditions.

Classified Shipment: Shipment assigned security classification by the shipper and requiring special handling by the carrier, consignee, and aerial ports/air terminals from origin to destination.

Close Blood or Affinitive Relatives: A permanent member of, and a resident in, a military member's or DOD civilian employee's household, and dependent on the sponsor for a home.

Coin Assist: Nickname used to designate the space available travel of dependent wives, accompanying dependent children, and dependent parents of military personnel reported missing in action or captured. This travel is for humanitarian purposes and is allowed upon approval of the Chief of Staff, United States Army; Chief of Staff, United States Air Force; Chief of Naval Operations; or the Commandant of the Marine Corps.

Commercial Augmentation: Airlift services provided by a commercial air carrier for the movement of DOD traffic. These airlift services augment the MAC ASIF organic capability in providing airlift services for DOD.

Common Carriage Cargo: That cargo moved in less than planeload lots by a commercial carrier not covered by a Category A contract.

Common User Airlift Service: The airlift service provided by industrial fund aircraft on common basis for all DOD agencies and as authorized for other agencies of the United States Government for the movement of cargo, mail, courier material, and passengers and their accompanied baggage over established airlift service routes, or over other than established routes between points mutually agreed upon by the airlift service operating agency and the agencies originating the request(s).

Competent Authority: An official bearing the title of commander or commanding officer or higher authority in the chain of command of the Army, Navy, Air Force, Marine Corps, Coast Guard (when assigned to the operational control of the Navy), the Reserve components of the aforementioned organizations, and the National Guard of the United States.

Competent Medical Authority: A physician cognizant of the medical needs of a sick, injured, or wounded person and having a responsibility to provide (or to arrange to provide) the necessary medical care for that person.

Consolidated Aerial Port System (CAPS): Third generation aerial port documentation system which will provide MAC with a single worldwide automated transportation documentation system.

Courier, ARFCOS: An officer, or an enlisted member in the grade of E-7 or above, of the Departments of the Army, Navy, or Air Force, assigned to a courier station to perform ARFCOS duties. They are identified by having in their possession ARFCOS Form 8, *Armed Forces Courier Service ID Card*.

Courier Material: Material accepted into the Armed Forces Courier Service (ARFCOS) for movement by agency airlift service aircraft.

Courier Transfer Station: A collection and control point for carrying out the mission of the Armed Forces Courier Service.

Critical Leg: That segment of a route which governs the ACL which may be carried over that route.

Customer: The department, agency, or individual responsible for reimbursement of the Industrial Fund for air transportation services provided by MAC, or other military airlift of the DOD.

Customer Identification Code (CIC): A group of up to 15 digits developed by the user service to enable identification of MAC charges within that service's appropriation and accounting structure.

Damaged Baggage: Damage to baggage, or contents thereof, while in the possession of the carrier.

Damaged Shipment: Cargo or mail in damaged containers whether or not contents have sustained damage.

Delay: A delay causes lateness; however, the criteria for military and commercial aircraft differ:

(1) **Military Aircraft:** For home station originating departures, a reportable delay occurs when the mission departs more than 0.2 hour (12 minutes) after scheduled takeoff time. For other military aircraft departures, a reportable delay occurs when a mission exceeds its scheduled ground time or scheduled time of takeoff, whichever is later, by more than 0.2 hour (12 minutes).

(2) **Commercial Aircraft:** On originating departures, a reportable delay occurs when the mission departs the blocks more than 0.3 hour (18 minutes) after scheduled block time. On en route departures, a reportable delay occurs when a mission blocks out more than 0.3 hour after its scheduled ground time or scheduled departure, whichever is later.

Department: As used here, refers to the Department of the Army, Navy, or Air Force.

Departure Time (Commercial): Commercial schedules reflect block-out time.

Departure Time (Military): Published time at which an aircraft is scheduled to take off.

Dependent:

(1) Spouse of authorized military or DOD civilian member;

(2) Unmarried legitimate children (including stepchildren or adopted children) under 21 years of

age; or children who are physically or mentally incapable of supporting themselves regardless of age if dependent upon the member for over half of their support;

(3) Parents of the member or the member's spouse if dependent upon the member or the member's spouse for over half of their support and actually reside with the member's household;

(4) Student dependents over age 21 for entitlement to transportation.

Depositioning Leg: That portion of a flight necessary to return an aircraft to its home base or station where it will resume its normal military operation upon completion of a directed operation.

Destination Station: Base at which a mission terminates as reflected in the MAC cargo and passenger schedules, mission setup message (AM-4), or OPLAN/OPORD, and where the mission identifier is changed.

Distinguished Visitor (DV): All US Military personnel (active and retired), foreign national personnel, and civilians in the grade of colonel, Navy captain, GS-15 or above.

Diversion Flight: Operational term for the inflight change of an aircraft's intended destination to any other airport. Diversion as differentiated from a re-route in that a diversion is effected during flight.

Diversion of Traffic: Traffic diverted from one mode of transportation to another. May also apply to traffic for which destination is changed en route (reconsignment).

Documented Weight: Total weight shown on TCMDs.

(1) **Nonpalletized shipments:** The actual TCMD weight.

(2) **Palletized cargo:** A total of TCMD weights of all the cargo on the pallet.

(3) **For manifesting,** the total of the TCMD weights of all the cargo listed on the manifest.

Domestic Shipment: Shipment between points within the CONUS.

DTS: Department of Defense Transportation System.

Dual Configured Mission: See Mixed Cargo and Passenger Missions.

Emergency Equipment: Survival equipment placed aboard an aircraft for overwater, polar, or desolate terrain flights.

En Route Station: Station between points of origin and destination at which the airlift mission will stop.

Escort: A member of the armed forces (to include DOD, contract, and other Government agencies' personnel) assigned to accompany, assist, protect, or otherwise insure the security, serviceability, or immediate employment of cargo at the destination stations. Escorts must possess travel orders in accordance with DOD 4515.13R, chapter 3.

ETA: Estimated time of arrival of an aircraft over a given point or station.

ETD: Estimated time of departure.

ETIC: Estimated time in commission.

Executive Director of the Single Manager Operating Agency for Airlift Service: Commander in Chief, MAC, is designated as the Executive Director of the Single Manager Operating Agency for Airlift Service with authorities and responsibilities for managing the agency.

Export Shipment: A shipment which is sent from any air terminal to another country.

Extra Section: A flight operated in addition to published schedules over the same route.

Fixed Schedule: Includes mission supporting frequency and readiness channels and a percentage of mission supporting requirements channels that are not subject to change except under exceptional circumstances. This mission listing of flights will be published semiannually in the Airlift Shippers Guide.

Flag Stop: A special stop by a scheduled mission at a station at which a stop normally is not made.

Found Baggage: Baggage or individual articles, such as coats, hats, gloves, etc., which are unclaimed; or baggage received but not listed on the manifest.

Frequency Channel: Service provided at a Headquarters Air Force approved frequency on the basis of user stated mission-essential needs, rather than as determined by cargo requirements forecast and/or generated.

Frustrated Cargo: Cargo which must be referred to the shipper service representatives for correction of packaging and/or documentation discrepancies before further processing can occur.

FSL: Forward Supply Locations.

FSS: Forward Supply Support: The system existing for the positioning of peculiar spares at selected overseas forward supply locations to support MAC en route aircraft. Resupply of spares is accomplished through primary supply points (PSP).

Generation: The traffic offered to an aerial port by the shipper services for movement via channel airlift. Normally relates to traffic forecast by the services as airlift requirements.

Green Sheet: A procedure whereby a specifically identified and urgently needed shipment of one service may gain movement precedence over all nongreen-sheeted cargo, including super priority 999 shipments.

Gross Weight: For palletized cargo, total weight of the cargo, pallet, and tiedown equipment; for unpalletized cargo, the actual (scale) weight of the cargo.

Ground Time: That period of time the aircraft is on the ground from arrival at the blocks to takeoff.

Grouped Channels: Low volume channels in the same geographical area that can be combined for purposes of operations. Individually, each channel may have a forecast under 300 tons a month, but by combining the tonnage and routing an aircraft through more than one APOE/APODs, more frequent service can be provided.

Hand Baggage: All baggage carried aboard the aircraft by a passenger, such as cosmetic cases, brief cases, shaving kits, small cartons, boxes, and packages.

Hazardous Cargo: Any material which, by virtue of its properties, is flammable, corrosive, an oxidizing agent, explosive, toxic, radioactive, or unduly magnetic. (See TM 38-250.)

High Frequency Channel: A frequency channel validated for operation three or more times a week.

High Volume Requirements Channel: A channel which has a user stated requirement for airlift of 300 tons or more each month.

Hi-Line Dock: A loading dock equipped with rollers.

Home Station: That base to which an aircraft is assigned.

Import Shipment: A shipment which is received at any air terminal from another country.

Inbound Shipment: Any shipment moving to an air terminal from another air terminal.

Inter-Theater Shipment: Any shipment which requires conveyance from one theater of operation to another theater of operation outside the CONUS, either by air, water, or land, including those shipments for which a portion of movement requires transshipment through CONUS facilities.

Intransit Passenger/Shipment: Traffic off-loaded at a station other than destination station, and placed aboard an aircraft at en route stations for movement to final destinations.

Intra-Theater Shipment: Any shipment which requires conveyance from one location to another location within a theater outside the CONUS by either air, water, or land.

Julian Calendar Date: A day of the year numbered consecutively from 1 January through 31 December, inclusive.

Loadmaster: An Air Force technician who accomplishes loading and off-loading aircraft functions; performs preflight and post-flight of aircraft systems; configures aircraft for specific airlift missions; computes weight and balance; insures safety and security of cargo, mail and baggage inflight; provides for safety and comfort of passengers/troops;

fulfills border clearance requirements; prepares supplies and equipment for airdrop; and conducts cargo and personnel airdrops.

LOGAIR: Long-term contract airlift service within CONUS for the movement of cargo in support of the logistics systems of the military services. (See QUICKTRANS.)

Low Frequency Channel: A frequency channel validated for operation less than three times each week.

Low Volume Requirements Channel: Requirements channels with monthly movement less than 300 tons, and frequency channels with fewer than three times each week service.

LRC: Logistics Readiness Centers. Coordinate with supply, maintenance, and transportation agencies to expedite monitored shipments of NMCS/VVIP items.

MAC Cargo Possession Time: Begins when cargo is receipted for at the APOE and terminates when cargo custody is transferred at the final APOD.

MAC Cargo Schedule: An operator-oriented publication that is published monthly. The schedule provides itineraries for the movement of passengers and cargo over established worldwide routes, served by either DOD aircraft under the control of MAC, or commercial aircraft under contract and scheduled by MAC.

MACOPS (MAC Operational Phone System): System consists of worldwide voice circuits and associated terminal equipment supporting the command control requirements of the airlift force.

MACTEL (MAC Teletype Network): Network of worldwide secure teletype circuits, associated terminal equipment, and communications center, which supports the command control record communications requirements of the airlift force.

Mail: Matter accepted into US civil or military postal service for transmission by agency airlift-service aircraft.

Man-days: The total number of actual working hours expended at the TDY location divided by eight hours.

This figure represents total man-days.

Manifest: Movement record of traffic transported on aircraft operated by, for, or under the control of, the DOD.

MATCO: Military Air Traffic Coordination Office. (See ATCO)

Maximum Gross Landing Weight: A fixed value based on structural limitations of the aircraft.

Maximum Gross Takeoff Weight: Stated allowable upper limit for the particular aircraft.

MILSTAMP: Military Standard Transportation and Movement Procedures, DOD Regulation 4500.32-R. States DOD policy and procedures to move cargo through the defense transportation system.

MILSTEP: Military Supply and Transportation Evaluation Procedures, DOD Regulation 4000.23-M. A DOD management information system which monitors the performance of supply and transportation systems to insure the UMMIPS standards are being met.

MILSTRIP: Military Standard Requisitioning and Issue Procedures, DOD Regulation 4140.17M.

Mission Identifier: A composite code of alphabetical and numerical equivalents composed of four parts: a mission number conversion prefix, basic mission number, basic mission number suffix, and scheduled operating date.

Mixed Cargo and Passenger Missions: Scheduled airlift missions designated in the MAC passenger/cargo schedule or by Headquarters MAC for the movement of both cargo and passengers, and requiring the following modified configuration:

(1) Passenger aircraft configured for the movement of passengers. When a minimum of 14 seats are removed to make space available for cargo and mail. Passenger missions are not considered mixed when small cargoes or mail are placed aboard.

(2) Cargo aircraft configured for moving cargo/mail. When a minimum of 14 seats (bucket or plush) are installed to accommodate passengers.

MMHS (Mechanized Materials Handling System): Any system of powered or automated equipment used for the express purpose of facilitating physical movement of cargo, mail, and baggage.

Movement-Ready Cargo: Shipments which have completed all processing steps and are in a configuration which allows aerial port shipping functions to select them for onward movement.

MTA: DD Form 1482, *MAC Transportation Authorization*. Used to document the movement of passengers via aircraft operated by, for, or under contract to, MAC.

MTMC. Military Traffic Management Command. The single manager operating agency for military traffic land transportation and common user ocean terminals. Serves as clearance authority for traffic entering the Defense Transportation System (DTS).

National Interest Traffic: Non-Governmental traffic, the movement of which the head of an executive department or agency considers to be beneficial to the political or economic interests of the US.

NMCS: Not mission capable supply.

Nonscheduled Missions: Nonscheduled missions include the following categories: MAC-directed special assignment airlift missions; special air missions; support; administrative, transfer of assignment, training, MAC AFs or unit support route familiarization; maintenance test; positioning or depositing missions.

No-Show Passenger: An individual with a confirmed reservation for a specific mission who fails to check in at the appropriate passenger service counter in time to be processed and manifested for that mission.

On-Time Arrival: Aircraft blocks in, on, or before scheduled arrival time, plus 15 minutes.

On-Time Departure: Takeoff of an aircraft at the scheduled or established time. Takeoff within 0.3 hours after scheduled or established time is an on-time takeoff.

Operating Weight: Basic aircraft weight plus weight of crew members, crew baggage, oil, emergency equipment, steward's equipment, and extra equipment. It does not include fuel or payload.

Operational Control: Authoritative direction necessary to accomplish the mission. In airlift operations, it includes authority to initiate, continue, reroute, divert, or terminate an airlift mission to accomplish the mission or in the interest of flight safety.

Operationally Ready Aircraft: An unlimited aircraft capable of flight, having all required equipment operationally ready to carry out the primary mission for which it is assigned.

Operations Center/Command Post (OC/CP): A functional element of an organization responsible for command supervision and control of aircraft movements. It is organized and equipped to gather, analyze, process, and present operational data as required to control MAC forces.

Operator: The airlift unit designated to conduct an airlift mission.

Opportune Airlift: That capability provided by non-industrial fund aircraft, not in a borrowed category, offered by the aircraft commander and utilized to move common user traffic. That capability provided by ASIF aircraft that are positioning/depositioning, to/from home station, for the purpose of operating a scheduled channel and SAAM mission. Also, that capability which becomes available on SAAM over and above the requirements of the user is offered to air terminals for the movement of common user traffic.

Outbound Shipment: Any shipment moving from an air terminal to another air terminal.

Outsize Cargo: Exceeds the capabilities of the C-130/C-141 aircraft and requires the use of C-5As. It is cargo that exceeds 828 inches long by 117 inches wide by 105 inches high in any dimension (the loading capability of the C-141 aircraft) and is qualified by the appropriate aircraft air dimension code assigned under MILSTAMP procedures. CRAF does not have the capability to lift any category of outsize cargo.

Overseas Shipment/Delivery Time Segment: The UMMIPS segment which begins when cargo is receipted at the CONUS aerial port of embarkation (APOE) and ends when the cargo is delivered to the overseas requisitioning installation. The time standard for transportation of priority one and two cargo for this segment is four days for UMMIPS Area 1 (Alaska, Hawaii, South America, Caribbean, North Atlantic), four days for Area 2 (Northern Europe, Mediterranean, Africa), and five days for Area 3 (Western Pacific).

Overshipment: Cargo or mail on board an aircraft, but not included on the manifest.

Oversize cargo: A single item that exceeds the usable dimensions of a 463L pallet, 104 inches long by 84 inches wide and 48 inches high.

(1) For military aircraft, oversize cargo exceeds the usable dimensions of a 463L pallet loaded to its design height 104 inches by 84 inches by 96 inches.

(2) For broad planning purposes, a 463L pallet loaded to a maximum height of 48 inches will fit all main deck loaded CRAF cargo aircraft, however, planners must realize that height increases are possible by contouring to the cargo envelope dimensions of the particular aircraft.

Palletized cargo: The total documented weight of all cargo placed on the pallet. The net weight is determined by adding the documented weight for each item/shipment as indicated on the TCMD.

Pallet Pits: A component of the MMHS consisting of a pit equipped with a hydraulic system that allows the pallet to recede into the pit as cargo is stacked on the pallet.

Passenger, Cargo Configured Aircraft: See Mixed Cargo and Passenger Missions.

Passenger Configured Aircraft: Aircraft employed principally for the transportation of passengers.

Passenger Loading Bridges: Covered walkway between the aircraft and the passenger terminal through which passengers are boarded.

Passenger Reservation Center (PRC): The organization within each MAC AF area of responsibility charged with the administration of passenger reservations.

Passenger Reservation Request (PRR): A request for airlift reservations from the military departments, MTMC or other elements of DOD to the MAC passenger reservation center.

Payload: That combined weight of passengers, baggage, mail, and cargo carried on an airlift mission.

PCAM: Punched card accounting machine.

Pilfered Baggage: Baggage reported as having been tampered with and/or contents removed.

Pilfered Shipment: Cargo or mail received in a condition that indicates tampering.

Pipeline: In logistics, the channel of support or a specific portion thereof by means of which material or personnel flow from sources of procurement to their point of use.

Port Holding Time: The total time elapsed between receipt time and departure time.

Positioning Leg: That portion of a flight necessary to place an aircraft from a station to a point at which a directed operation commences.

Processed Time: The hour and date that a shipment becomes available for movement and is entered into the port on-hand level as either loose or palletized.

PSP: Primary Surplus Points.

QUICKTRANS: Long-term contract airlift service within CONUS for the movement of cargo in support of the logistic system for the military services, primarily Navy and Marine Corps. (See LOGAIR.)

Readiness Channel: A service justified, Headquarters Air Force approved inter-theater frequency channel that sustains an air line of communication by providing the minimum frequency of service to insure UMMIPS time standards are met in support of material readiness of major deployed weapon systems. Service above the minimum frequency is determined by the additional tonnage forecast/generated by the user(s).

Receipt Time: The date and time the cargo shipments are offered to the APOE/APOD or air terminal by the person or persons effecting delivery; that is, truck arrival, aircraft block, etc.

Rehandled:

(1) Aircraft: Originating, terminating, and through aircraft requiring any type of traffic service by aerial port operations due to aircraft aborts or delays.

(2) Traffic, Passengers, cargo, and mail which are physically off-loaded and reloaded; including palletized cargo requiring resequencing, repalletization due to reconfiguration, or diversion to another destination or mode.

Reparable Cargo Shipment: Unserviceable items being forwarded to a repair activity.

Requirements Channel: A MAC channel which serves two points on a scheduled basis, depending on volume of traffic forecast generated by the user(s).

Retrograde Cargo/Mail: Cargo which originates in overseas areas, moved by any mode of transportation in the reverse flow of a normal traffic pattern, destined to and terminating in CONUS.

Route: A pattern of fixed geographical positions that when connected, establishes the authorized flight track between point of origin and destination for MAC mission.

Route Support: Support given by additional airlift missions necessary to maintain scheduled operations. Route support may include direct support of aircraft parts and components and ground support items, as well as transportation for personnel directly involved in route support.

Scheduled Departure Time: The published time at which an aircraft is scheduled to take off.

Scheduled Mission: Mission published in the MAC cargo and/or passenger schedules.

Seats Available: The total seats available for each manifest destination.

Senior Lodger: A CRAF carrier selected by MAC to coordinate all CRAF functions at a designated dispersal, regroup, APOE, or en route station. The senior lodger is the central point of contact between carrier personnel at the airfield and the CRAF Air-lift Schedule Center. (See MACM 55-8, volume I.)

Short Shipment: Cargo or mail that has been manifested and is not aboard the aircraft.

Single Manager for Airlift Service: The Secretary of the Air Force is designated as the Single Manager for Airlift Service with authorities and responsibilities in DOD Directive 5160.2.

Single Passenger Reservation Center (SPRS): The MAC worldwide Passenger Reservation System.

Space Assignment: That space assigned within MAC airlift services capability — military and commercial — to airlift user forecast requirements.

Space Available Traffic: That traffic authorized for movement as outlined in DOD 4515.13-R.

Space Block: A reservation of space made for an en route station by the control agency. This reservation is made to insure the movement of onload traffic from en route stations.

Space Required Traffic: Those categories of reimbursable traffic as outlined in DOD 4515.13-R.

Special Air Mission (SAM): Missions operated by aircraft assigned to the 89 MAG in support of the special airlift requirements of the DOD.

Special Assignment Airlift Mission (SAAM): A mission operated by MAC (other than the 89 MAG) at the request of the Departments of the Army, Navy, Air Force, and/or Marine Corps only.

Split Shipment: A shipment unit divided into smaller movement units.

Sponsoring Agency: Departments of the Army, Navy, Air Force, or Marine Corps authorizing the air movement of traffic.

Sponsor Service Representative (SSR): Representative of the department or agency responsible for the funding of the airlift. The SSR is usually referred to

as APLO, MATCO, ACA, etc.

Stowaway: An unauthorized individual who conceals himself aboard the aircraft for the purpose of obtaining illegal passage.

Stowed Baggage: See checked baggage.

Super Priority Cargo: Cargo that has a transportation priority of 999 or higher.

Surface Lift Time: Elapsed time between transfer of cargo custody at the APOD and receipt by the overseas requisitioning base.

System Entry Time: The time shipment arrives at the initial aerial port of embarkation. This time will stay with the shipment through the system regardless of intransit points until custody is transferred at the final MAC APOD. The concept is designed to provide accurate visibility of total MAC possession time which the aerial port will use for moving cargo on a first-in, first-out (FIFO) basis based on time in the airlift system.

System 463L: A materials handling system compatible with various modes of transportation required in accomplishing the air logistics and aerial delivery mission. Included in the system are the aircraft with dual rail systems; material handling equipment (MHE) such as K-loaders, 10K forklifts, and the pallet/net module; and mechanized materials handling systems (MMHS).

Tare Weight: For palletized shipments, the weight of the pallets and nets used.

TCMD (Transportation Control and Movement Document): A MILSTAMP document prepared by the shipper for each shipment of cargo/mail.

Terminal Reservation Section (TRS): A section located within MAC air terminals, operating as an extension of the passenger reservation center, to handle reservation actions required after the PRC relinquishes control of a mission to the terminal.

Through-Shipment: Cargo that remains associated with a mission through successive en route stops.

TMO (Transportation Management Office): The branch of the aerial port squadron that accomplishes surface transportation of people, household goods, baggage, cargo, and mail. This agency belongs to host base overseas.

Traffic: Cargo, mail, courier material, passengers, and patients, and their accompanied baggage, accepted for movement via airlift service aircraft agency.

Traffic Control Section: See air terminal operations center.

Traffic Documentation: The forms used to process, record, and report the handling and movement of traffic by the airlift service.

Transportation Account Code (TAC): Transportation account code is a four-digit code for inclusion on transportation documents to identify the appropriate DOD agency and transportation account chargeable for movement of cargo and mail.

Transportation Information Processing System (TIPS): A management information system designed to process transportation data received from aerial ports worldwide. The system provides the Command transportation management information used in planning allocation of resources and to analyze system performance.

Transshipment: At an en route point, the downloading of cargo from one aircraft, reprocessing the accompanying documentation, and loading that cargo aboard a second aircraft for onward transportation.

UMMIPS: Uniform Material Movement and Issue Priority System. DOD Instruction 4410.6. Specifies incremental time standards for requisition, issue, and movement of material for the DOD. The time standards apply to all transportation modes, and vary according to the priority and the ultimate destination of the shipment.

Unaccompanied Baggage: That portion of a member's prescribed weight allowance of household

goods or professional books, papers, and equipment, or any combination thereof, which is not carried free on a ticket used for personal travel, or which normally is shipped separately from the bulk of household goods.

Unauthorized Baggage: Baggage weight above the authorized baggage weight allowance on the travel orders. Further, those items specifically prohibited by law.

Unit Learning Center: A program or environment in which instructional technology (including the ISD process) is specifically directed at the instruction of individuals or small teams. While the most visible aspects of a learning center are generally the devices and carrels, the courseware aspects are of equal importance. Courseware virtually always is locally or specifically prepared. It includes a learner-centered environment, with emphasis on both self-pacing and self-selection among alternate instructional packages, and alternate presentations of the package. These presentations may vary in terms of media type, difficulty level, or purpose (that is, overview, instruction, review, etc.). Often the program is conducted in a series of learning stations or carrels in which automated presentations include visual presentation of what to do, and verbal presentation (written or auditory) of how to do it, with provisions for actual task performance. Considerable emphasis is placed on instructional strategies, with frequent elicitation of specific response and confirmation of the appropriateness of the response. Learning centers may be enabled by a computer which facilitates the presentations, records and/or intercepts the performance, and may assist in pacing and sequence selection. It must be stressed that a learning center is a program and not merely a facility; it is something you do, not something you buy.

Unpalletized Cargo: The weight of the item/shipment as indicated on the TCMD.

Unprocessed Cargo: Cargo whose documentation has been processed to and annotated by the aerial port/air terminal with a receipt time.

APPENDIX C

STANDARDIZATION AGREEMENTS (STANAG)

The following STANAGs are relevant to the scope of this manual. They are available to Department of Defense personnel; requests should be mailed to the Naval Publications and Forms Center (NPFC), 5801 Tabor Avenue, Philadelphia, PA 19120. DD Form 1425 should be used to requisition the documents.

STANAG NUMBER	TITLE
2023	<i>Marking of Military Cargo for International Movement</i>
3093	<i>NATO Air Transport Requests and Answer to Air Transport Requests</i>
3345	<i>Data/Forms for Planning Air Movements</i>
3400	<i>Restraint of Cargo in Fixed Wing Aircraft</i>
3462	<i>Availability of Weight and Balance Requirements and Loading Criteria for Fixed Wing Aircraft</i>
3463	<i>Planning Procedures for Tactical Air Transport Operations</i>
3465	<i>Safety, Emergency and Signalling Procedures for Military Air Movement Fixed Wing Aircraft</i>
3466	<i>Responsibilities of Air Transport Units and User Units in the Loading and Unloading of Transport Aircraft in Tactical Air Transport Operations</i>
3467	<i>Characteristics of Air Transport (Airlanded) Pallets for Carriage Internally</i>
3543	<i>Air Transport Cargo/Passenger Handling Systems — Request for Information</i>
3548	<i>Tie-Down Fittings on Air Transported and Air Dropped Equipment and Cargo Carried Internally or Externally by Fixed or Rotary Wing Aircraft</i>
3631	<i>Wartime Air Movement Priority System for NATO Countries</i>
3739	<i>Combined Air Terminal Operations</i>
3770	<i>NATO Baggage Tags</i>
3771	<i>Aircraft Anti-Hi-Jacking Procedures</i>
3854	<i>Policies and Procedures Governing the Air Transportation of Dangerous Cargo</i>



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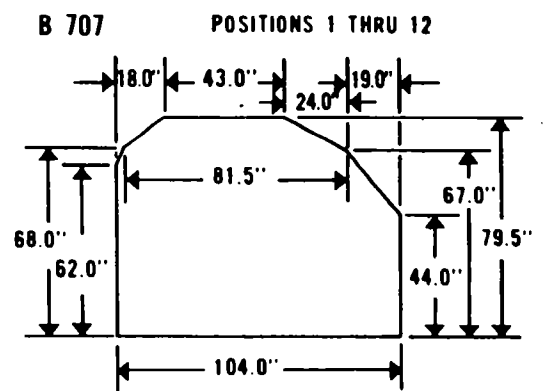
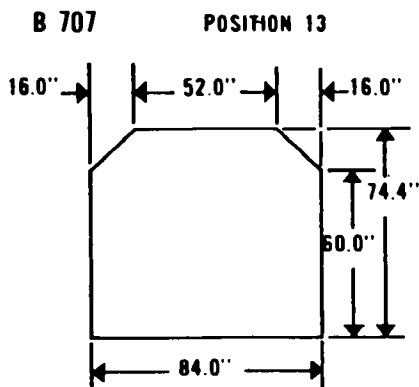
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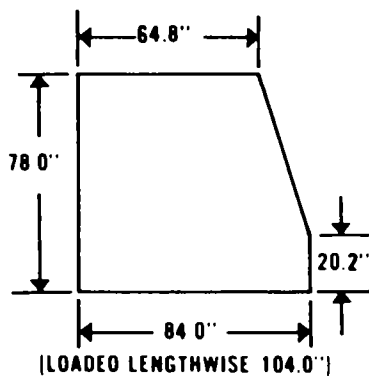


APPENDIX D CRAF PALLET PROFILES

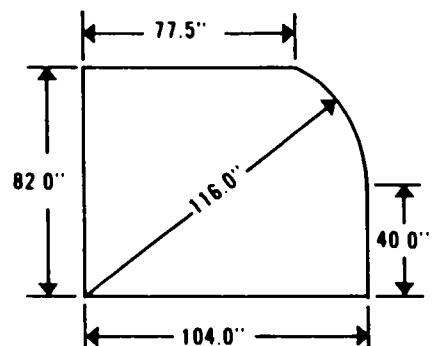
(MEASUREMENT TAKEN FROM PALLET SURFACE)



DC-10-10/30CF **POSITIONS 1L & 1R**
13L THRU 15L
13R THRU 15R

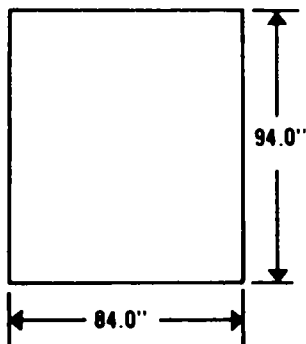


DC-10-10/30CF **POSITIONS 2L THRU 12L**
POSITIONS 2R THRU 12R



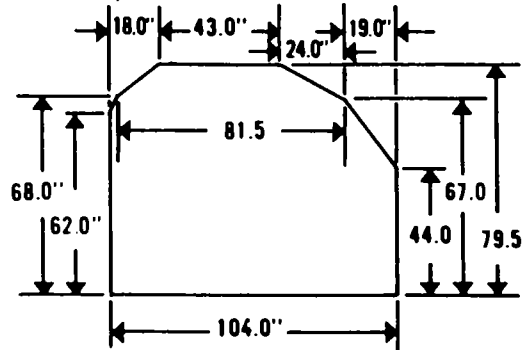
B 747-100F/200C/200F
(ALL MAIN DECK POSITIONS)

PALLETS CAN
BE LOADED
LENGTHWISE
(104")
OR
CROSSWISE
(84")

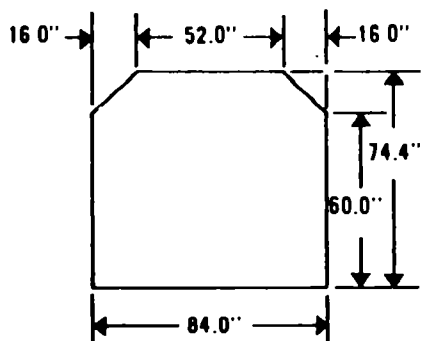


DC-8-33F/50F/CF
DC-8-62CF
DC-8-61/63CF

POSITIONS 1 THRU 11
POSITIONS 1 THRU 12
POSITIONS 1 THRU 16

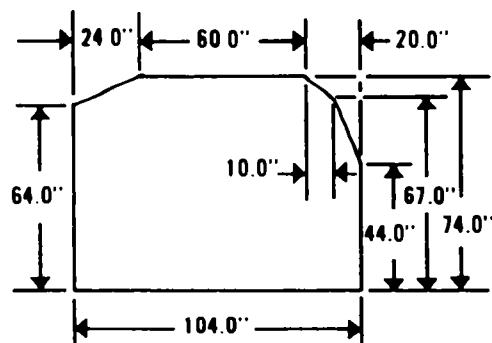


DC-8-33F/50F/CF POSITION 13
DC-8-62CF POSITION 14
DC-8-61/63CF POSITION 18



DC-8-33F/50F/CF
DC-8-62CF
DC-8-61/63CF

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POSITION 13
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FM 55-9

31 AUGUST 1981

By Order of the Secretary of the Army:

E. C. MEYER
General, United States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Brigadier General, United States Army
The Adjutant General

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